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THE MENACE TO NIAGARA.

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FORECASTS by eminent geologists of the future of Niagara Falls have been much in the public eye and have lost some of their novelty though none of their interest. The great cataract, it is said, is committing suicide, and the physical factors which enter into the process have, it is thought, been carefully weighed. If matters proceed as they are now going, the face of the cataract receding without interruption, the falls are to wear themselves out, or if the dominating crustal movement continues, the escarpment is to be left bare because its waters will be stolen away and turned back into Lake Erie.

These are interesting possibilities, but they hardly rise to the dignity of probabilities, for opposing considerations have been left out of the calculations and even the remote periods assigned to their arrival grow longer and more distant in the face of factors overlooked or not sufficiently estimated. Nothing can be as wrong as mathematics or logic where the premises are wrong; nothing more excusable than the trial forecast for the life of a spectacular natural phenomenon, even though it will be and remain improbable till every factor in play has been given its full share in the process.

The problem of Niagara is not simple. As one sees with each change of the sun a new wonder in its fascinating rush of waters, so every reconsideration of the problem of its natural future brings into activity contributory and qualifying elements before unrecognized.

The intelligent public, now quite familiar with these forecasts, looks upon the Niagara cataract as doomed at some remote time and from causes which human power can not control, and doubtless this

feeling, now that the novelty of the sensation is past, has been followed by an intellectual resignation. Even the claims of posterity, the passing pang that our descendants may not see the mighty cadence of water as our eyes see it, quite relax all hold upon us in view of the fact that after all this may not happen just as represented.

The heavy bed of tough dolomite limestone at the crest of the falls, which is the occasion of their existence, lies above a thick mass of soft shale which easily caves in under the rebound of the falling waters, and by so doing becomes the chief cause of the breaking down of the crest and of the cataract's retreat. This bed of shale runs down into the earth in the direction from which the water comes, the south. It will be out of the reach of the cataract after a while, leaving an escarpment wholly composed of the tough limestone, which will make the problem of retreat thenceforward quite a different one from what it is to-day. There are, moreover, fifty-seven feet of hard dolomites above the crest of the falls over whose edges the water now descends in rapids. As the cataract moves southward by the falling away of its rock face it will grow higher instead of lower, until after it has passed the parting of the waters above Goat Island. Indeed it may become fifty feet higher than it now is and so firmly upheld by the heavy masonry of limestones that caving in must cease and further retreat will be reduced to its slowest terms.

As to the crustal movement whose tendency is to spill the waters westward out of the Erie basin, we may observe that the earth's crust is most uneasy and its movements most uncertain. Nearly every place is going either up or down, few are in a state of actual quietude. These movements have every variety of period; some may be secular, some are known to be relatively brief. Fifty years ago the shore at Percé on the Gaspé coast was going down, the fishermen had to abandon their drying stages and build them farther up the beach, but to-day the shore is coming up again and excavations for the new stages reveal the remains of the old ones which have been buried in the sea for nearly two generations. There is no knowing when the movement now affecting the Niagara region will cease.

Public resignation over the natural but distant fate of Niagara has grown to public concern at its immediate future. It is alleged that the present and contemplated industrial development at Niagara Falls immediately imperils the integrity and perpetuity of that great spectacle. Is this true? If it is, the American and Canadian public who hold this phenomenon in trust for the world ought to know it. However this question may be received and however answered by the interested producer or the disinterested public, it has on more than one occasion been flatly and formally before the people of the State of New York and of the Province of Ontario and has had to be met.

The legislative bodies of these two governments must meet it again, for it is plainly not the present temper of the public to let it pass in uncertainty.

Any citizen of New York or Ontario may justly take a pride in the magnificent industrial development building up about Niagara Falls, even though it is all at the cost of the beauty and magnificence of the cataract. Nowhere else has nature afforded such tremendous power at once available to mankind and calling forth the highest play of his genius. If I could hold a brief for the development of these natural resources it would be the delight of my pen to paint the wealth, the contributions to human comfort which will flow from them. I might argue that nature created this tremendous fall of water for the express purpose of contributing to commercial power and industrial supremacy. Such a brief would lament, as I have heard a distinguished engineer lament, the actual waste of power during the ages in which the great river has been discharging itself in unutterable glory and construe it sinful to neglect the opportunity so lavishly afforded. Such a brief might deride and cachinnate at the possibility of ever diverting enough water from Niagara to make the Falls palpably less, and all these arguments it would not be difficult to enforce with specious reasoning and pleading facts.

The attitude of the man who is willing and ready to see Niagara entirely drained for the wealth it would produce, and only a dreary canyon left to speak of its splendid past, is wholly intelligible, or would be except for the potent facts that wealth and happiness and contentment are purely relative and that the natural forces of the world were not created for the use of man.

The question I have put has been not only asked, but answered, in New York, officially. The abstraction of water from Niagara Falls was condemned by a committee of the constitutional convention appointed to investigate this subject in 1894, when the public had begun to suspect that the legislature had been too free with its gifts of franchises to power companies. It was vigorously and effectively answered by Governor Odell in 1904, who stood out finely against a tremendous pressure brought to bear upon him by the industrial interests, not through any hostility to them, but for the simple sentimental reason that the Falls must be conserved. Few know the courage of this act, but it was a triumph of sentiment and morality which the citizens of New York may well applaud.

The editor of the POPULAR SCIENCE MONTHLY has asked me to set forth the facts relating to the situation at Niagara Falls in such form that it may be made clear whether existing and impending conditions there constitute an actual menace to the cataract and its accompanying attractions, or whether public apprehension has been un-

necessarily aroused by a kind of pantophobia which may work a real injustice to industrial progress.

Except for that slender radical element of the community which proudly avows its willingness to see the Falls wholly developed into power all will agree that if danger is impending to the cataract it is time now that the danger be measured and fully apprehended.

The conservation of Niagara Falls is a question of public morals. Every industrial enterprise of wide scope has as its foundation a moral problem; it can not be simply the producer of great wealth regardless of the rights of others and of the higher claims of community life; nor can it ignore the claims of spiritual excellence and of the higher life which seeks something beyond the minted ideal. This claim of the higher life, the demands of the finer emotions, the love for the beautiful in nature, express themselves in part in the government protection of natural wonders from defacement and destruction; in organizations created to keep alive this sentiment and extend the ægis of the state over natural glories which belong to mankind rather than to men. No wise man confesses himself devoid of such emotions.

The violation of this moral principle in present practise offends the best sentiments of the race. It is said that the classic Falls of Lodore have been done to death by conversion into power. The far-famed Falls of Montmorency at Quebec show only a tremulous and weakened front to the traveler on the St. Lawrence, shorn of their glories in order to light the City of Quebec. The City of Rochester, seat of learning, refinement and industrial achievement, has exchanged the beautiful cascades of the Genesee for a slimy canyon. These attacks on natural phenomena have benefited the few, contributed to their comfort and convenience; they have injured the many, robbed them of a natural and proper heritage.

Under the guidance of this principle the claim of the individual, personal or corporate, must give way to the broadly founded rights of the community and the race. Under whatever political control such a majestic demonstration of nature's power may be, this control must be looked upon as a trust rather than the possession of a merchantable commodity or a commercial asset. States have not the moral right to do as they please with such phenomena. In a final analysis the individual or corporate claim to advantage from such a source is wholly extinguished, howsoever expediency may qualify and adjust the conflicting claims.

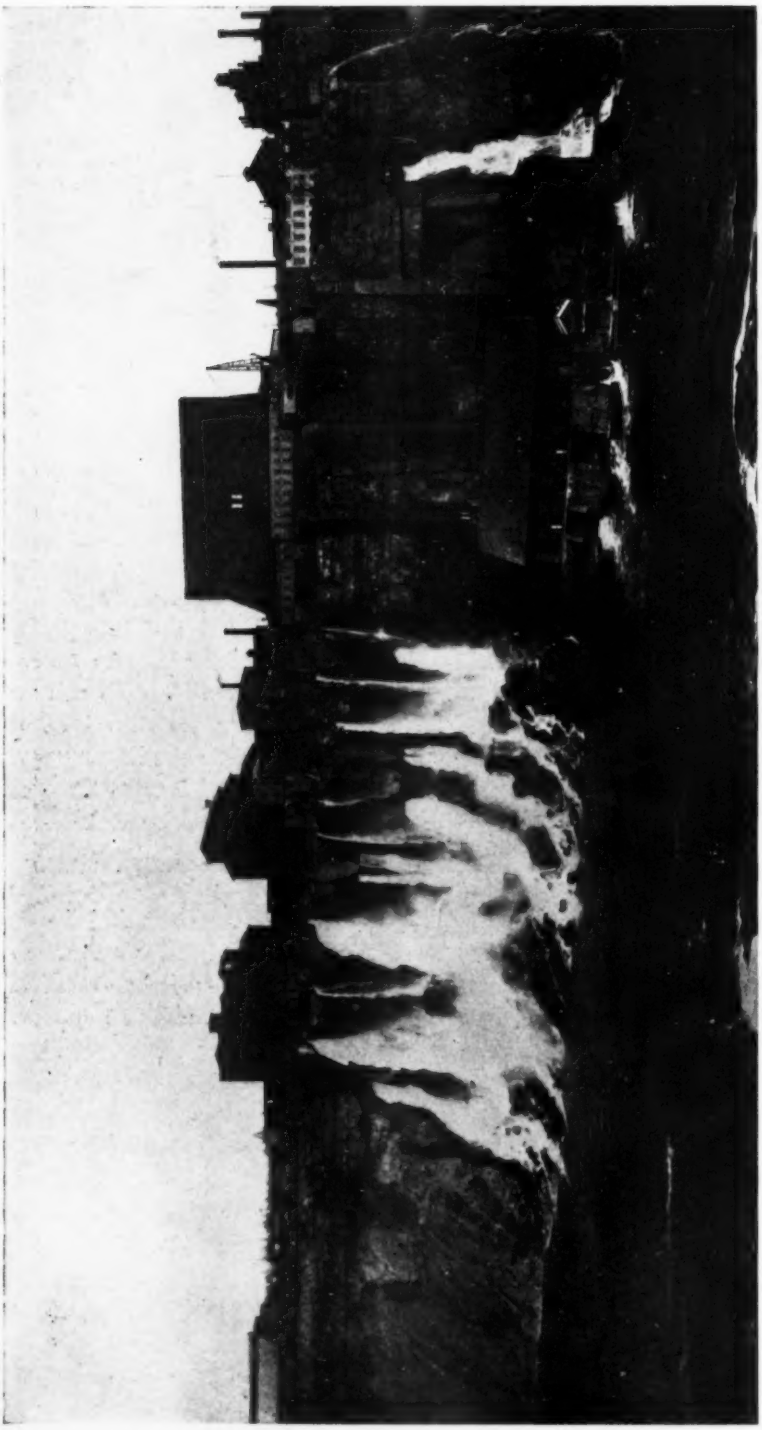
Wherein does the danger to Niagara Falls from industrial development lie? Simply in the drawing off of its waters from the river above the cataract, carrying them around the cliff by some other way or discharging them by tunnel into the face of the falls near the base.

The use of Niagara waters for power production has been the dream of years and its earliest successful achievement is expressed in the present Niagara Falls Hydraulic Power & Manufacturing Co., whose existence as an active consumer of Niagara water antedates its statutory recognition. The legislature of New York began giving away franchises to power companies about twenty years ago. It has never asked a financial return of any sort for any of these, as, during the

THE AMERICAN CHANNEL AT THE CREST OF THE FALLS DURING THE ICE JAM OF MARCH, 1903.

period from 1885 to 1894, when they were most freely granted, it probably seemed not wise to inflict a revenue on a budding industry. New York thus receives nothing whatever in return for the privileges it has granted for the consumption of its own waters. We mention this fact incidentally, just as we may mention that the Canadian companies are to pay a substantial return for similar privileges; but this matter of revenue has no bearing whatever on the theme before us. Whether or not any public revenue be derived from the use of Niagara is entirely beside the issue save as taxation of the product of the companies can be used as a means for the control of the situation.

Nine of these companies have been legally recognized or chartered in New York. Of these charters, all were granted in good faith, but it may be doubted if all were asked for and received in the same spirit. Some, it would seem, were immediately for sale as soon as



A VIEW OF THE AMERICAN BANK, SHOWING THE POWER-HOUSE OF THE N. F. H. P. AND M. CO., THE ENCLOSED TAIL-RACES AND THE GROWING ROW OF STRUCTURES AT THE EDGE OF THE WATER.

granted. Some failed to effect organization because the present requirements of such an undertaking demand enormous capital. Some were limited in respect to the amount of water they may abstract from the river, as the Niagara Falls Hydraulic Power & Manufacturing Co., to 462,000 cubic feet per minute, and the Niagara Falls Power Co., to 516,000 cubic feet per minute. Others were restricted in the amount of power to be produced, as the last named company, which may not exceed 200,000 horse-power. In most cases, however, no limitations were placed either on power to be produced or water to be abstracted. Several were limited as to the time in which they were to begin work in good faith, two of them to five years, two to

THE AMERICAN BANK BELOW THE STEEL ARCH BRIDGE, SHOWING THE WASTE OF WATER AND POWER FROM THE SPILLWAYS AND TAIL-RACES OF THE FACTORIES.

ten years. Three if not four of the charters are dead by limitation, one company sold its franchise to another, one is slumbering with an occasional show of life, another is leading a questionable life and two are producing and selling power.

The Niagara Falls Hydraulic Power & Manufacturing Co. and the Niagara Falls Power Co., the productive organizations, are alone to be credited with the really amazing industrial developments at this place, and they are still far within their statutory limitations in the consumption of water. With this superb display of mechanical achieve-

ment before his eyes one looks and looks in vain for a depauperated and enfeebled cataract. The flow of water is of course diminished, but to the occasional visitor it is but mathematically perceptible. Citizens of Niagara Falls who have the cataract daily before the eye have insisted that the loss of water is perceptible, and that such loss is felt in other ways is seen in the now annual gorging of the ice in the American channel at the upper end of Goat Island, which lays bare the American channel, sends all its water to Canada, and which very rarely happened when the depth of the water was normal.

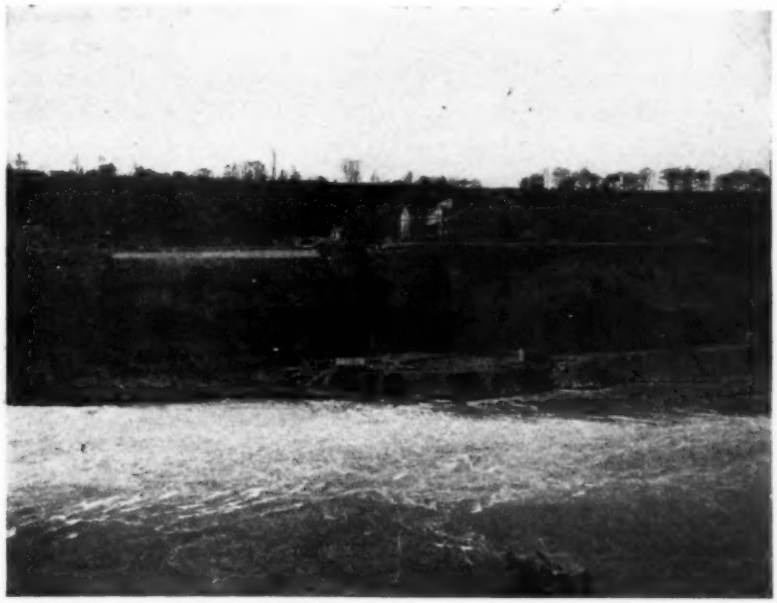
The two active American companies are not going to use any less water than now, but are vigorously increasing their output and building new power houses to meet their growing market. Indeed, one of them, realizing its close approach to statutory limits, has established itself on the Canadian side. These two companies are permitted to consume the following amounts of water:

Niagara Falls Hydraulic Power & Manufacturing Co.....	7,700	cu. ft.	per sec.
Niagara Falls Power Co.....	8,600	"	"
	16,300	"	"

The water abstracted by these companies is in no small degree wasted, that is to say the power produced is no equable measure of the amount of water taken from the river. This page carries a picture familiar to a thousand eyes—the view of the American bank below the steel arch bridge. This has been termed 'the backyard view of Niagara. The little cascades springing from holes in the side of the bank at various heights are the wasteways of the factories above. Some of these cascades are now encased in flumes and made productive at the bottom of the cliff, but this is only a recent change designed to save the wasted power, but involving the construction of a row of factories or wheel pits all along the edge of the water. The fall from the height of waters where these two companies have their intakes, to the base of the cataract, is approximately 224 feet, far beyond the working possibility of the turbine pit. The outrush of water at the base of the cliff near the bridge anchorage is the discharge of the great tunnel of the Niagara Falls Power Co., which is the tail-race from the wheel pits far back up the city and far above in the rocks.

On the Canadian side the activity in the erection of power works has been more strenuous. Utter devastation of the natural beauties of Queen Victoria Park, the demolition of islands and creeks, the excavation of the rock surface to the complete obliteration of well-known landmarks, have been the accompaniments of the unparalleled endeavors and achievements here. Whoever has visited this part of the Falls region since the beginning of these gigantic operations has sought in vain for the Dufferin Islands and Crescent Island, and what must have seemed to him an inextricable chaos of rock excavations, of

switches and sidings, of temporary and permanent constructions, in confusion worse confounded, has confronted him. Out of it all, it is presumed, the plans for the *artificial* beautifying of the spot will gradually unfold and the visitor of coming years is to see it with its attractions not only restored, but enhanced.



SITE OF THE POWER-HOUSE OF THE ONTARIO POWER COMPANY AT THE EDGE OF THE WATER BELOW THE FALLS ON THE CANADIAN SIDE.

Great sections of the river bottom, acres of rock over which the river has flowed for ages in tumultuous energy, have been for the first time exposed to the eye of man and the light of the sun. These sections of the river have now in large part been absorbed into forebays and intakes, into the permanent constructions of the companies, never to be given back to their proper charge.

The three Canadian companies are to be greater consumers than the American. They are the finest, the most magnificent conceptions of hydraulic engineering, and in their ultimate realization rise to proportions which are an expression of the genius that has inspired them. No one of these, let us remark, is moribund or inactive; each shows the highest type of virility.

The Canadian Niagara Power Co. has a statutory limit of consumption of	8,900	cu. ft.	per sec.
The Ontario Power Co.	12,000	"	"
The Toronto & Niagara Power Co.	11,200	"	"
	32,100	"	"

Adding to this total the limits of the American producing companies (16,300), we have for the entire chartered abstraction of the five companies referred to, 48,400 cubic feet per second.

This is of itself a dry and apparently barren fact. Let us look to its bearings upon the structure of the Niagara River and the total flow of waters through its channel.

The Niagara River flows over a rock bottom, on which the strata dip uniformly to the west. The sill or edge of the Falls is ten feet higher on the American than on the Canadian side, the waters at the crest of the American Falls ten feet shallower.

THE ROCK-BED OF THE RIVER ON THE CANADIAN SIDE, NOW PARTLY ENCLOSED BY PERMANENT CONSTRUCTION.

The flow of water through the channel and over the Falls was measured by the United States engineers in 1868, and by Sir Casimir Gzowski in 1870–3, with results varying from 246,000 cubic feet per second (the latter) to a maximum of 280,000 cubic feet per second (the former). The later averages given by the United States engineers, derived from the mean flow of water from Lake Erie at Buffalo during a period of forty years, afford 222,400 cubic feet per second. There are certain constants of abstraction for the Welland and the Erie canals which may be regarded as equalized by the inflow of streams into the river between Buffalo and the Falls, so that the figure which has been generally accepted and has entered into the calculations

of the engineers is 224,000 cubic feet per second. It is in cubic feet per second that we prefer to express our statements; the attempt to put them in terms of horse-power is attended with too many uncertainties.

The potential or theoretical horse-power of this volume of water falling in the cataract is variously, sometimes carelessly stated in the engineers' reports as from three to six millions. A recalculation gives it at 3,800,000 for the cataract, which would be increased by the additional fall from the height of the rapids to the crest of the Falls. Goat Island, picketing the frontier, divides the waters unfairly, giving much more than three-fourths of their volume to the Canadian side,

THE ROCK-BED OF THE RIVER, LEFT DRY BY THE WING DAM OF ONE OF THE CANADIAN COMPANIES.

though the international boundary established by the Treaty of Ghent lies at the line of deepest water. Now as less than one fourth of the total volume of the waters pours down the American channel and this channel is much shallower than the other, it is at once evident that abstractions of water will make themselves first perceptible in the shoaling of the American channel. At the parting of the waters above Goat Island the great current of the river moves to the west, and converges into the funnel of the splendid Horseshoe Falls. The American channel actually carries in comparison but a feeble flow and the whole American cataract is in extremely delicate equilibrium.

A competent hydraulic engineer, taking the accepted volume of

the flow, the length of the entire crest of the Falls on both sides (4,070 feet) and the difference in elevation of the sill of the Falls, has calculated that when the flow is reduced to 184,000 cubic feet per second, or by 40,000 cubic feet, the water will be down to the present rock bottom at the edge of the American shore.

WING DAM OF ONE OF THE CANADIAN COMPANIES RUNNING OUT TO THE EDGE OF THE RAPIDS.

Then the American Falls, though still forming a cataract, will be but a ghost of their ancient magnificence; instead of the mighty sheet of emerald waters now spreading in silent majesty over the rock crest, a weakly, thin, white apron of waters carried forward by a slender impulse *a tergo* and the great cadence will have lost its glory. Electric searchlights in all the colors of the rainbow dancing up and over the falling waters and other factitious means of producing a spectacle will never compensate the loss.

Let one fifth more of the water be abstracted beyond the line we have already calculated and the American channel will be dry. That is, in effect, double the amount of 40,000 cubic feet, and when 80,000 cubic feet have been taken away from the present flow the Canadian channel will still be an interesting object, but the American Falls will be wholly gone.

All our figures in these statements and calculations, it may be well to repeat, are taken from the reports of the United States engineers, of the power companies' engineers, or have been specially derived at my solicitation by engineers of high standing.

We may return to the data given concerning present and immediately contemplated abstraction.

The two American and three Canadian companies now in opera-

tion or about to operate, when producing to their charter limits will abstract 48,000 cubic feet per second. That amount will bring the water-level to the bottom of the river at the American shore.

So much then is in immediate prospect. The turning of the waters a few days ago into the largest turbines the world has ever seen, thus inaugurating the actual production of Canadian power, sounded the death knell of the American Falls, leaving to those whose hearts sink and whose spirits shrivel at the thought of this destruction only a slender hope that it may be mechanically impracticable or commercially unprofitable to produce to the maximum amounts.

We are not permitted to stop with this forecast. One of the companies chartered by the legislature of New York and the last so chartered to abstract water from above the Falls, is the Niagara, Lockport & Ontario Power Co. It received in 1894 a franchise without restriction upon the amount of water it might use, but work was to begin in good faith within ten years. It was a modest organization with a slender capital, too slender, as it proved, to begin operations. It did nothing, but in 1904 came to the legislature of New York asking an improved charter enlarging its powers and extending its time. This company proposed to take its water from far above the cataract, as far back as La Salle, and not to return it to the river channel at all, but to carry it off overland by canal to Lockport, emptying it thence into Lake Ontario. The bill passed the legislature, not without commotion, but encountered trouble in the Executive Chamber. We have referred to the veto of this bill by Governor Odell as a fine act. Perhaps it is not necessary to say more, but the act was done in the face of most turbulent and insistent opposition, and it was clearly actuated by a relentless conviction of the higher rights of the citizens of the state. *Ex cathedra* statements by special attorneys and the company's engineers that no damage to the scenic features of the Falls could result, were supplemented by an offer of a tremendous sum to the state treasury for the governor's approval. The veto met with almost universal applause throughout the state. This veto was signed May 15, 1904. The company's old charter was signed May 21, 1894. There remained six days in which the company could get to work under its old charter. There is said to be to-day a slender ditch up south of Lockport, the work of a few men and a few carts, which represents the work done *in good faith* in the six days between May 15 and May 21, 1904. It has become a matter of common knowledge that this company has reorganized since these dates, increasing its capital enormously, and it is also stated that the stock has largely passed from the original organization into the control of one of the great corporations. It now looks as though this company means to do business if the courts have no objection, either

under its old charter or with a new one if it can get it. Its intentions and organization are not a negligible quantity in contemplating what is going to happen to Niagara. Should it succeed in constructing its canal and works it is not likely that with an unrestricted charter the company will consume less than 10,000 cubic feet of water per second, and if we assume this as a fair expression of its mean consumption we must increase the mortgage on the Niagara waters by this amount. It then becomes 58,400 cubic feet per second.

These are then the demands upon the river which are actually in sight.

In the seventh annual report of the Commissioners of the Queen Victoria Niagara Falls Park (1903), Mr. Isham Randolph, of Chicago, advisory engineer for the commissioners, makes, at the request of the board, a report on the 'Further Development of the Niagara River for Power Purposes,' in which he suggests sites for four additional companies to consume in total 29,996 cubic feet of water per second. We may better construe this proposed abstraction as operations under consideration rather than merely as work suggested. If we add the amount to our last figure the result, 88,396 cubic feet per second, leaves the entire American channel as dry as bone.

Such is the situation. We are out in the open with these figures. They are the figures of the engineers themselves. The counter-argument to these statements has been, so far as the writer's experience goes, either incorrect premises or a rather bored smile. Putting aside entirely the merely proposed developments and considering only those actually in process we see how closely we are brought to the dead line for the American cataract.

What are we going to do about it? A small, very small proportion of the community in New York and Ontario is content to let the process continue, even to the extinction of Niagara. This element of these communities is largely directly or indirectly concerned with the industrial developments there. Outside the boundaries of these trustee governments this percentage is greatly less. In the country as a whole, speaking for the general intelligent public, the opposition to this procedure seems so overwhelming as to be practically unanimous. New York long ago recognized the necessity of conserving such of these natural beauties as have fallen to her share and the state reservation at Niagara is one of the most beautiful of parks, lamentably small in view of the present encroachment, but upon it she has spent some millions of dollars. The Province of Ontario joined hands in this endeavor and the Queen Victoria Park was once and will be again a beautiful spot, all the more beautiful, the commissioners think, after the installment of the power companies is complete.

The president of the New York Reservation has stated that 800,000 tourists visit the Falls each year. This is a vast number, bringing in an enormous revenue to the place. No other evidence is required to demonstrate how closely the interest of the whole world is focused on Niagara, for these visitors are representatives of every nation. How many hundreds of thousands will seek out Niagara when the world learns that the Delilah of commerce has shorn it of its glory? Will they traverse the seas to behold the wonders of a breakfast-food factory or of any other industrial triumph? These are everywhere; Niagara is

COMMERCIAL NIAGARA—THE CANADIAN BANK BELOW THE BRIDGE.

unique. To make the problem equable, when will the power developments here put into circulation as many millions of money as do the visitors at the Falls? It is not good business to let the Falls alone?

There is widespread power throughout the country about Niagara, in central and western New York and in southern Ontario—not in concentrated and overwhelming manifestations, but power is running away now in many a stream which might be developed and stored without offense to the world and with profit to the community. While this power lying at our doors is neglected the apology for the desecration of Niagara lacks the ring of sincerity.

There should be a remedy for every public menace. If there is in the American people, especially in the citizens of New York and Ontario, a sturdy purpose to save Niagara, if it is proposed to meet the

problem and solve it, it will be found to possess difficulties enough. The working companies are established in their rights and entirely correct in their demeanor toward the state. The legislature of New York in 1904 memorialized the President upon the subject, urging the initiation of treaty relations with the King of Great Britain having for their purpose the cessation of further abstractions of water. It has been suggested by an influential newspaper that the end may be approached through a presidential commission which shall first determine how much water may be taken from the river without detracting from the scenic effects. Our figures show plainly and cogently that such procedure is useless because too late. They show that even the existing abstraction of water is qualifying the majesty of the Falls and that the contemplated authorized abstraction will carry the work of destruction well toward its finish. No more franchises are likely to be granted by either of the trustee governments. It may be well if these states or the superior government of each should enter into a treaty agreement to insure this result, but the danger-point being so near, in fact constructively passed, protection for Niagara means *control of power production*. The hope lies herein, that the companies, either through mechanical limitations, difficulties of cheap production or cheap transportation to a distant market, or through taxation of their product, may not be able to reach the volume of abstraction which is to seriously involve the splendor of the cataract. In this age of marvels, no present mechanical obstacles will long hold sway; the genius of man will overcome them all. In taxation of the power product, not necessarily for revenue but for protection, seems to me to lie the sole means of control of the problem, the only way of saving our national pride before the bar of the world.

SUNSPOTS AND WEATHER.

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IT is perhaps not far from the truth to say that the most pressing problem, as far as the daily needs of humanity are concerned, consists in finding some method of predicting the weather. Of the great value which a solution would have it is not necessary to say a word. Yet, in spite of many attempts, the chief problem is as yet unsolved. One may go a step further and say that there is at present no indication of any approach to a solution in the work which has hitherto been published. It is possible to forecast the weather with fair accuracy for a day or two in advance, but the methods by which this is done do not appear to have any bearing on the problem of predicting what the weather will be next week, next month or next year. The latter question must be approached in a quite different manner, and it is the object of this article to show the degree of success attained by one attempt to disentangle the wider fluctuations of climate which nearly every region of the earth's surface shows from year to year.

Weather and climate, like all other phenomena of nature, are nothing more than particular cases of the interaction of certain laws. Properly speaking, chance plays no part in their variations. That the motions of the atmosphere can be classed under well-known mechanical principles, there can be little doubt; that the various types of weather and climate are capable of being deduced from those principles with a sufficiently powerful method of analysis is equally certain; but whether such a method has yet been invented or is in process of being discovered at the present time is open to doubt, if we may judge from the very little that has hitherto been done in the direction of deducing the observed phenomena from the laws which govern them. The difficulties presented by this natural and logical process have caused meteorologists to turn to some other method of restoring order out of the chaos. Instead of deducing the phenomena from the general laws, attempts are being made to bridge the chasm which separates them by starting with the observations and trying to find out if some kind of order can be discovered—a support on which it may be possible to continue the bridge towards the opposite bank.

The procedure to be adopted when the latter method is used is sufficiently simple. Large numbers of observations of temperature,

barometric pressure, rainfall, etc., are made and recorded. We may use one of two methods to examine them. The first is to group the observations in various ways until we discover some group or groups into which the observations appear to fall. This method, however, entails such an enormous amount of labor that it has rarely been adopted. It is only successful in the few cases where the general nature of a group appears without much trouble. The second method is to assume that the observations must run in series which are repeated after definite intervals of time. These intervals of time are in reality obtained from the general physical principle that if any force is periodic, that is, if its fluctuations are repeated after a definite period of time, then certain of its effects are also repeated after a definite period of time, which is the same as that of the force. The first method is an attempt to construct the bridge by starting from one bank and building piers or supports on which the structure may be gradually extended across the chasm; the second method resembles a series of cables thrown across in the hope that they may be attached firmly enough on each bank to bear the weight of the bridge.

There is no difficulty whatever in attaching two of these cables to both sides. Whatever other causes operate, there can be little doubt that the sun must play some part in governing the climate of any particular place. The day and the year are therefore marked out beforehand as periods into which observations of temperature can be grouped, and these periods are fully confirmed. If the temperatures be recorded every hour out of the twenty-four for a large number of days, and the average temperature for each hour be formed by adding all the observations for that hour and dividing by the number of them, we obtain a series of twenty-four average temperatures. When the number of days on which observations are recorded is great enough, these averages will show a regular change rising to a maximum, for most places, in the early afternoon and descending to a minimum in the early morning hours. A similar method followed with the average temperature, say, for each day, will show a yearly period in the observations.

We thus get a series of average temperatures for each hour of the day and for each day of the year. But these are only averages and they only present regularity when very large numbers of observations have been used in forming them. At any particular time the difference of the actual temperature from the average temperature for that time may be as large or larger than the greatest difference of the averages during the period. It is evident then that other cycles must be sought which, by their combined effect, will give the actual temperature at any particular time. And what has been said about temperature can be said to a greater or less degree about the other phenomena, such

as rainfall or barometric pressure, which it has been customary to record. We find periods of a day and a year, but the differences of the averages from the actual observations are very considerable.

The next step consists in trying to find out whether cycles can be discovered in these differences, and for this purpose the same method is followed. But the periods to be examined are by no means obvious. The time of revolution of the moon, under the supposition that the moon has any influence, is not found in meteorological observations, or at any rate the effect is so small as to be negligible in comparison with what we want to find, and no other astronomical period seems very likely to find a counterpart in the records. There is, however, one period which at first sight appears to be a possible one in meteorological observations, namely, that known as the sunspot period. Before going into the evidence for its existence as a climate factor, it is necessary to say a word or two about the effects of periodic changes.

These changes may be roughly divided into two classes, those of short period and those of long period. From the former we should expect changes from day to day or every few days, constituting what we usually call the 'weather.' Nothing at all is known of the existence of any such period, all attempts to trace one having ended in absolute failure. The long period changes are in general those which affect the character of a season and which show the difference between one season and the next, or the variations which a given season of the year will show in several successive years. In countries where the most important interests are manufacturing and ocean transportation, the 'weather' is the first consideration; in lands where the agricultural interests are predominant, although the weather is important, it is more essential to have an idea of the climatic or seasonal changes. Thus if the sunspot period could be shown to have a large influence on the climate of any region, we should be able to forecast to a corresponding extent the general characteristics of future seasons, and lay plans accordingly. The practical value of such an investigation is obvious, but its scientific interest is not less if it leads to a more accurate knowledge of the laws of nature. The case therefore deserves examination.

In order to establish any connection between sunspots and meteorological changes, two things are necessary. First, the periods in which the sunspots can be grouped must be discovered and their relative importance determined. Second, the meteorological records over long intervals of time must be examined in order to see whether they exhibit similar cycles of change and whether those cycles, supposing that they exist, are sufficiently well-marked to be considered important factors in the variations of the seasons at any place from year to year.

Although the existence of sunspots has probably been known from

the earliest times, the fact that they undergo periodic changes in number and size was not recognized until long after the discovery of the telescope, and the law of the change was not determined with anything like accuracy until the middle of the last century. Accurate observations of their number and size were only commenced about 1830, but from about 1750 to 1850 enough material had been gathered to show that a maximum occurred on the average every eleven years. In the last two or three decades the use of the spectroscope has added greatly to our knowledge of their nature and motions, and the photographic camera has enabled astronomers to add permanent records of the state of the sun's surface at any time to the numerical estimates which were the chief contribution of the earlier observers. Such pictures are of special value whenever, as in the case of sunspots, much depends on the personal equation of the observer and still more on the particular method used in forming an estimate of them. Thus there is a period extending over the last seventy years in which continuous observations have been made, a period of another seventy years earlier in which the observations are worth discussing, although much less reliance can be placed on them for accurate deductions, and a still earlier period of about a hundred years from which a little doubtful information can be gleaned.

The net result which has been deduced from this series is an average period of $11\frac{1}{9}$ years between the maxima or times of greatest sunspot activity. But this average period by no means represents all the facts. The time between two consecutive maxima has been as long as 17 years and as short as 8 years, while some maxima are marked by much larger and more numerous spots than others. The average period between the minima or dates of fewest sunspots is rather less irregular, since it has never been known to differ by much more than two years from the mean period of 11 years. There is some evidence that these stronger and weaker maxima themselves run in a cycle, but the period is very doubtful. Wolf, who devoted most of his life to the investigation of sunspots, deduced a period of 55 years for this longer cycle, while there are later determinations of 65, $35\frac{1}{2}$ and 61 years. Further, the curves representing the number of spots from day to day or from month to month show many other irregularities which have up to now defied any attempt to group them in any regular order. Thus we have a well-marked average period of about 11 years and doubtful ones of about 35 and 60 years. These are therefore the periods into which the meteorological records are to be grouped in order to inquire whether there is any connection between the two sets of phenomena.

There is good reason to believe that a period of about 35 years is to be traced in certain of the meteorological records, and therefore it is

important to know how much dependence can be placed on the evidence for the existence of a similar period in the sunspot observations. In 1900 Dr. Lockyer took Wolf's sunspot numbers from 1833 to 1900; these numbers show six maxima and six minima of the average eleven-year period. But the interval from a minimum to the next following maximum is not the same for each of these six periods; it varies from 3½ years to about 4½ years. The six numbers representing these intervals were arranged according to their proper dates and it was noticed that they could be made to fit in with a periodic change of about 35 years in length. Again, the area of the sunspot curve from one minimum to the next was found, and another set of six numbers was obtained, the last five of which would again fit into a 35-year period. The two series corresponded well with each other if we excepted the first of each, the reason for the exception being that there was a doubt as to the observations from which the first number of the second set is obtained having been made on the same plan as the others. Unfortunately, the evidence thus presented is far from conclusive. There is nothing unnatural in the two series agreeing with one another as far as a period is concerned since they were deduced from the same set of observations. The difficulty arises in the attempt to find the length of the period from five or six numbers spread over rather less than two revolutions of the cycle. One would prefer to say that this result was a reason for further investigation rather than that it proved anything definite as to the existence of a 35-year period.

Far more numerous are the difficulties which beset an examination of the conditions on the earth's surface. In the first place, accurate observations are practically confined to the latter half of the last century, and these have been made chiefly in the northern temperate zones where the daily and weekly changes are apt to be very irregular and violent and where the local conditions frequently exercise much influence in determining the weather or climate of a particular place. To obtain averages free from these local and temporary conditions requires the examination of a very large number of observations extended over a long period. In the second place, the observations at one place should be kept separate from those at other places, for it is theoretically possible and even probable that a maximum at one place of observation may occur at the same time as a minimum at another place. For example, the yearly averages might show that a maximum rainfall in one place always occurred with a minimum rainfall in another, and *vice versa*. If the results from the two places were combined, a part or the whole of the periodic change would be lost. Then again, there is no clear indication what observations should be chosen for examination; average daily temperature, maximum or minimum daily temperatures, rainfall, number of violent storms, number of days

when the barometers or thermometers were above or below certain marks, and so on.

In dealing with any complicated problem it is usually best to try and simplify it as much as possible, and if the problem even then appears too difficult, to attack a special case, and this is undoubtedly the best plan to pursue here. In order to avoid the rapid fluctuations which occur in the temperate zones, meteorologists have turned to places in the tropics where the types of weather during the course of a year are apt to be much more permanent and where the changes from one year to another are likely to appear more clearly than in other regions of the earth. It seems to be generally agreed that, owing to its political and geographical situation, India is the country best fitted to satisfy these various conditions. The most marked peculiarity of its climate, taking the country as a whole, is a rainy season extending over some two or three months, with comparatively little precipitation per month during the rest of the year. Independently of the scientific side of the question, the quantity of rainfall and the duration of the rainy season are of immense practical importance, since a deficiency in either may and usually does involve a famine. An examination of Indian records may therefore be of great value; and as a fairly continuous series of observations at several observatories has been obtained for some twenty or thirty years, it may not be too early to commence a systematic examination of them.

Several investigations in this direction have been made lately, unfortunately with but little success in obtaining positive results. Here it is advisable to set forth with a little more detail what is meant by 'success,' since it is necessary to have a clear conception of the value, both scientific and practical, to be attached to the results of investigations based on the theory of averages. A set of observations is recorded and an examination of them is made with a view of finding out the existence of a cycle. Suppose that one cycle is found, but that its effect on any individual observation is very small. For example, if the temperatures at any particular place vary in the course of a year from 20° to 90° and we find a cycle running through all its changes in eleven years and having a maximum effect of 1°, the daily temperatures are scarcely altered if we subtract the amount corresponding to this long-period variation. Thus, though the cycle may be thoroughly well made out, it tells very little about the variations of temperature. It is only when we are able to get a sufficient number of periodic changes whose combined effect will fairly well represent the individual observations that we can be said to be at all successful in our analysis of the latter, and it is only then that a basis is found sufficient to predict the future numbers of the series.

Of the various attempts to trace long-period changes in the

meteorological records, only those will be taken in which some possible relation to the sunspot periods may exist. Thus a search is to be made for 11-year periods to establish a good connection; the 35-year period may furnish a possible connection between the two sets of phenomena, although, as we have seen, its existence in the sunspot curves is too doubtful to demonstrate the existence of the connection, while the 55- to 65-year periods, even if they exist in the sunspot curves, are too long to make a demonstration possible within the range of the recorded meteorological observations.

The best proof of the existence of an 11-year period has been furnished by Köppen, who showed that there was such a cycle in the combined mean annual temperature of many places within the tropics. But the total range of variation is only about three-quarters of a degree, while the mean annual temperatures show variations of from five to ten degrees. This appears to be the only well-established quantitative result with respect to the 11-year period. But several qualitative examinations have been made and the recent ones chiefly refer to rainfall and famine in India. Sir Norman and Dr. W. J. S. Lockyer have examined the rainfall statistics in India and Mauritius and they come to the conclusion that India has an increased rainfall near the sunspot maximum and Mauritius one near the sunspot minimum, and further, that the latter gives rise to a smaller pulse of rainfall in India. Thus India has two periods of increased rainfall, a large one near the sunspot maximum and a smaller one near the sunspot minimum. Unfortunately this investigation only refers to a single period of eleven years—from 1877 to 1886. They have also brought forward some evidence which indicates that the famine years occur between these two pulses of rainfall. The results do not seem to be sufficiently well made out to prophesy future famines with any certainty. Last year another writer showed a connection between certain Greenwich temperature records and the 11-year period, but the differences shown were very small. Other investigations on the same lines indicate about the same or a less degree of success in the discovery of a sunspot period.

In view of the doubtful existence of a 35-year period in the solar activity it is unnecessary to say much concerning a similar period in terrestrial phenomena. The most thorough investigation is that of Brückner, who examined a very large number of temperature records from all parts of the earth and deduced from the annual means a period of this length. But the amount of the change is only half a degree Fahrenheit, while the annual averages differ amongst themselves by from 5° to 10°.

In summing up briefly the results of the evidence hitherto presented, it must be admitted that no case has been made out in favor of a

definite connection between the number and size of the spots on the sun's surface and the weather or climate on the earth. On the other hand, theoretical reasons would lead us to expect some connection, and the evidence is rather in favor of it than otherwise; but it is highly probable that the direct effect of the spotted area is unimportant compared with the effects produced in our atmosphere by other causes.

Although a negative answer must at present be given to the question whether sunspots have any considerable share in the variations of climate, it would be leaving a wrong impression if no mention were made of a well-established 11-year period in the variations of another set of terrestrial phenomena. The state of the earth's magnetism has for many years been carefully recorded by suitable instruments and there is no doubt that its fluctuations correspond quite closely with the state of the sun's surface, not only in the cycle of long period, but also with respect to the minor variations. It can not as yet be stated that the appearance of a group of sunspots always causes a disturbance of the magnetic needle, but investigations have been published and others are still under way which appear to show a very intimate connection between them. Nothing is known as to the causes of this connection.

We have been dealing hitherto with only one exhibition of the solar activity. It is one which catches the eye and is perhaps well adapted to show the main features of this activity in somewhat the same way as the presence of snow and ice would indicate the higher peaks of a mountain range. Pursuing the simile, while it is true that we get an idea of the more prominent outlines of the mountainous region by noting the white places on the dark background, the latter would include many elevations and depressions which are never touched by snow, and we can not have a correct idea of the range without finding some method of observing them also. The case of sunspots is not very different. They probably form the bolder outlines, but, as Professor Bigelow has pointed out, they constitute but a sluggish register of the solar activity. There is another set of variable phenomena, known as the prominences, which are now supposed to furnish a much better index of the state of the sun at any time. These are elevations of the material of which the sun is composed, visible round the edge of the disc, and they appear to be huge masses of liquid or gaseous matter violently ejected from the main body. Unlike the sunspots, prominences are rarely absent and some of them can nearly always be seen on the edge of the sun's disc, so that by recording the number and height of those observable from day to day a much more continuous and accurate series showing the activity of the sun can be obtained. Moreover, it has been shown that the variations in the series correspond much better with those in the earth's magnetic force than

do the variations of the sunspot records. As yet, the number of years in which a continuous account of the prominences has been kept is too small to establish any good connection with the long-period or climatic changes on the earth's surface. It was only in 1868 that Lockyer and Janssen devised a method of observing them at times other than those rare ones when the moon comes in front of the sun's disc and leaves anything protruding from the edge of the latter in plain view for a few seconds. In general, large and numerous prominences are associated with the presence of sunspots, but prominences are frequently observed when no sunspots are visible in their neighborhood.

While this new method of noting the prominences in preference to the sunspots will probably improve our knowledge of what is going on in the sun, there is some tendency towards a change in the methods of observing the terrestrial atmosphere. The possibility of obtaining observations at heights of 2,000 feet or more above the earth's surface has directed attention to the fact that we are much more likely to get results free from local influences in this way, and perhaps a continuous series of such observations may show better any regular changes in the atmospheric phenomena. At the same time, the opinion has been strongly expressed that the observations already at hand should be sufficient to give the main features of the weather and climate if they can tell anything at all, and that it is time to stop the huge accumulation of records of temperature, rainfall, etc., and to undertake the thorough examination of those in our possession. There is undoubtedly great need for this: a plenteous harvest, with perhaps many tares and but few laborers.

In conclusion, while it is not my purpose to go into the reasons why more or fewer sunspots and prominences should affect our atmosphere, a few words may be said on the subject in order to counteract a widely spread misconception. Because the sunspots are dark areas, it is supposed—and one sees the statement frequently in the popular prints—that a portion of the sun's heat is screened off and the immediate deduction is made that 'cold waves' are the result. The first idea is very probably the exact opposite of the truth, and there is no theoretical or observed foundation for the second. As a matter of fact, it is generally agreed that sunspots and the associated prominences are evidences of increased activity, and therefore that they should denote a greater instead of a less output of solar heat. The amount of the change in the solar heat from time to time is as yet unknown; investigations in this direction are only in their infancy. Moreover, it is probable that the changes are too small to very materially affect terrestrial conditions, and even if they do so, the nature of the effect is quite doubtful. For example, an increase of heat from the sun may produce increased evaporation from certain water areas of the earth's

surface, and the moisture thus drawn up being carried away by the movements of the atmosphere, may be deposited elsewhere in the form of snow or rain. It is almost impossible without a much more intimate knowledge of the laws governing the movements in our atmosphere to say in advance what the effect of a slow and periodic change in the sun's heat will be. Although the change in any one year may be small, its effect on the earth in the course of a number of years may be cumulative and thus become very evident; or other circumstances, for example, a corresponding periodic change in the radiation of heat from the earth, may so counterbalance the change in the heat received from the sun that the effect of the latter is scarcely perceptible.

The conclusion of the whole matter has been well expressed by Professor Cleveland Abbe: that the key to the weather problem is not to be found in the sun or indeed in any external influence, but that the solution is to be worked out by the conditions which hold in the atmosphere itself—conditions which can only be discovered by a thorough examination of the internal laws of motion, quite apart from any external forces which may modify the results.

MEDICAL RESEARCH: ITS PLACE IN THE UNIVERSITY MEDICAL SCHOOL.*

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IF there be one word which is heard most frequently in the most intelligent circles interested in professional education to-day, it is the word research. In our own country in recent years medicine has fallen under its sway, and on all sides efforts are being made to meet its demands by the erection and equipment of costly laboratories within whose walls research may be carried on in a continuous and orderly manner.

Granted that the governing bodies of our great universities have familiarized themselves with the significance of this word and are giving it out, some only with the lips, others with a thorough conviction that to it must be accorded a permanent place in our higher institutions, the problem of how to deal with such a costly, and in many ways unattractive, offspring, how to correlate it with the teaching function, how to cultivate it side by side with the routine methods of instruction, will occupy a prominent place for years to come.

Research signifies effort directed toward the discovery of laws and principles through the systematic collection of new, and the better correlation of existing, data. It also means effort directed toward the more efficient and economical application of discoveries to the welfare of man, in other words, the utilization of latent and hitherto wasted energy. The aims of research are not culture, not miscellaneous information, not a mood of leisure meditation upon the origin of things, but mainly utility and service to mankind.

The chief influence at work in lifting medicine from a mere teaching to a research level is the same as that at work throughout the world of science and in fact in all intellectual fields. If we examine it more closely we find it akin to the breaking away from authority and dogmatism in religious affairs and from autocracy in the government of nations. Its foundations rest far down in the great liberalizing wave of the nineteenth century. We no longer believe that each step in advance is the ultimate one, but only one in a series toward ultimate truth, and this fact makes us realize that we must keep on marching.

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Research recognizes no immediate boundary to its activities, and no limit to its possible acquisitions. In placing only a temporary value upon its constructive plans and using theories only as aids to new facts, science grows in candor and modesty with its achievements.

In biology and medicine, the spirit of research takes into account the continual movement and flux in living things and their environment. It is a study of change, of transformation, brought about by conditions which may or may not be under experimental control. We describe carefully and minutely, not for the sake of the picture and its details, but chiefly to be able to recognize the change. Unless we know the consecutive pictures how can we detect the movement and its trend? It is the moving picture of the kinetoscope that has gradually replaced the single view in repose.

But there is danger that we may move too rapidly and find our advanced positions untenable. The world is just now very optimistic and expectations run high. If we give way to the feverish haste of our day, the slow, sure advance of medical science may be brought into discredit. For it is one of the features of this feverish haste to leave the position held as soon as possible for one more advanced. We move away because we have some doubt as to the security and trustworthiness of our present position, and we hope to gain by pushing beyond it rather than strengthening it. As a result of this attitude we find the thing most characteristic of the day and age is the rapid remolding of our stock of information. Revolutionary views are uttered from an inadequate basis of observational and experimental data. Theories become kaleidoscopic in their variety. Old views long since discarded come to the surface like old fashions. All this change and ferment is both the cause and the effect of the enquiring attitude of mind. Research begets new data and the opposition to these begets new research. Thus the fermentation is kept up and a froth several years deep lies on the surface which few can penetrate.

This haste and hurry is part and parcel of what might be called nature's lavish waste of energy. The volume of our information increases more rapidly than our knowledge of the principles which underlie and support it. The progress actually made is more apparent than real. It is a swaying to and fro with but little forward movement. Like the driftwood of which the waves are endeavoring to unburden themselves, many excursions back and forth must be made before the fact is finally landed. It is often much battered and barely recognizable.

That there is here a golden mean to be followed need not be emphasized. The spirit of research should be properly tempered by a true insight into the relation of enquiry to the great accumulation of knowledge and the reserve forces stored in the every-day experience of mankind and handed down from generation to generation.

In the meantime the optimism of the world which unknowingly assumes that medical science can rise above natural law and correct any and all excesses of individuals and communities must be met by a better education in natural science rather than abandoned to the manipulations of the charlatans of physical and mental healing.

Passing now to the more obvious external conditions which have tended to stimulate medical research, we may single out a few which have been of special importance. Perhaps the most ancient and strongest of all is the desire in the human breast to maintain health and prolong life. From its very beginnings the healing art has been weighed down with the greatest of problems, to save life and to cure disease, often in those of lofty estate, and its status for the time being frequently depended on its success or failure in accomplishing apparently the impossible. In our own day the crumbling of the formal religious belief that this life is but a preparation for that beyond the grave and the centering of our efforts to make it as much of a success as possible, the growth of wealth and leisure and the pursuit of sensual pleasure, these various motives, high and low, combine to exert a pressure upon medicine which is scarcely equaled in other professions. To save life, and to cure disease are imperative demands which grow more urgent, more impatient each year, and which suffice to quicken the efforts of the scientist and the true physician as well as the charlatan, and shape almost every problem which is considered worthy of attack to-day.

As a most important and timely contributory force to the advancement of medical research in recent years are the princely gifts of benefactors, with whom we especially associate the names of Johns Hopkins, Garrett, Fabyan, Rockefeller, McCormack, Payne, Morgan, Huntingdon, Sears, Stillman, and many others without whose aid medical research could hardly have commanded a corporal's squad to-day.

A factor not to be neglected in the advancement of medical science is the feeling of national pride. Most of the medical science of the past and much of the current knowledge has on it the mark 'made in Europe.' To-day this mark is occasionally being replaced by the label 'made in America,' and without doubt the home market will soon be well supplied. Fortunately, tariff barriers and trusts do not interrupt the currents of knowledge. Without hindrance we have filled our storehouses from the old world and I trust that we may repay in due time some of our huge indebtedness. Our national pride once awakened will see to it that our country, the wealthiest in material things, shall continue to give as well as to receive the fruits of the intellect.

These are forces acting chiefly from without. Perhaps the most

important acting from within has been the use of animals. The study of the great domain of infectious diseases has revealed such a similarity between the diseases of man and the higher animals that we hesitate now less than before to apply courageously the knowledge gained in our experiments upon the highest mammals to human physiology and pathology. Without this aid from animal life, medicine as a progressive experimental science would dwindle into insignificance. Moreover, the artificiality, the rigidity and awkwardness of the medicine of a generation ago have been largely dissipated by its contact with biology, which brought with it the comparative point of view.

Side by side with the use of animals we may place the convenient use of bacteria and other microorganisms in our laboratories in producing disease as one of the great levers of pathological research today. They have enabled the investigator to establish important centers of research completely independent of and coordinate with those connected with the hospital and the dead-house. The latter, it is true, still remains a final court of appeal for all discoveries destined for the relief and cure of human diseases.

In the historical development of science the research instinct appeared at first sporadically, and until recently it was simply the spontaneous flowering of the scholarly mind in the highest institutions of learning. To-day it has been actually organized not so much to train youth as to produce useful knowledge. This new organization of research has been greatly favored by the promise of valuable returns in the suppression of infectious diseases of man and animals. Most of the institutions founded thus far were created by public authority for this purpose. It was realized that such work must be pushed forward rapidly to secure results of value to public health and economy.

About twenty-five years ago special laboratories began to appear. Our own government figured among the earliest in voting what were then very liberal appropriations for the study of infectious animal diseases. At the same time came the German Imperial Health Office and somewhat later the Institute for Infectious Diseases in Berlin, and the Pasteur Institute in Paris; more recently there have been established the Institute for Experimental Therapy in Frankfort, Germany, and the many sero-therapeutic institutes and public health laboratories, nearly all of which have become noted for their research work. In our own country we have last but not least the Rockefeller Institute for Medical Research of this city and the Memorial Institute for Infectious Diseases in Chicago. Most of these were created to deal scientifically with problems of immediately practical bearing. But it does not need a prophet to foresee that following them others will arise which will devote themselves to broader and more fundamental problems and which will attack those left unsolved by the former institu-

tions. Of this latter class the Pasteur Institute in Paris and the Rockefeller Institute are conspicuous examples.

The founding of research institutes does not guarantee their success. That will depend upon the men who work in and for them. It has become evident that our research workers must have more diversified training than the older generation possesses. The store of knowledge accumulated by science must be made available to medicine. The only way in which this can be accomplished is to have trained men continually examining and testing this accumulating store of facts and applying them to the problems of disease. Such men should have medical training and approach their problems from the medical point of view; but to them should be spared the necessity of learning ultimate details of the medical art and they should give their energy to some sister study, be it morphology, physiology, chemistry or pathology. Medicine has just begun to realize the need of drawing to itself the great talent which hitherto has had an open door only to the pure and applied sciences. Research is largely dependent for its successful pursuit upon an attitude of the mind which insists on following a clew that promises to reveal some relationship, some law of causality between phenomena hitherto apparently unrelated. This type of mind has many of the attributes of the inventor who is attempting to combine to our advantage the forces of nature in new and unlooked-for ways and to express them in the form of labor-saving machines. In order to attract these minds we must pay them a living wage and provide workshop and tools, and exercise but moderate restraint over their activities. To them the exterior of practical medicine has a forbidding aspect. We must bring them to face its really wonderful problems through the portals of the laboratory.

After we have established research institutes and brought together a devoted, enthusiastic group of scientists we must not look too closely at the immediate practical value of research. Most of the epoch-making discoveries have had little, if any, direct influence on medical practise at the start and even for some time after. Some have wholly failed to yield hoped-for results, but they have had great influence in unexpected directions. This is chiefly because great discoveries are as a rule not ripe for use. To point out a hitherto unrecognized cause does not thereby enable us to overcome its effects. These may be grounded in centuries of adaptation. A great discovery frequently does no more than call attention to a new fact without defining its relationships. The discovery of the tubercle bacillus for example left the whole question of its complex relation to a given host untouched. The same may be said for most other microbes. The delicate equilibrium between parasite and host is the thing to be worked out before we can rationally proceed to upset it in our favor. There is there-

fore no need of hurrying to put discoveries to use. Many are discredited because of such ill-advised attempts and the investigator himself becomes discouraged in the futile effort to apply principles which fit only in part the practical condition to be influenced.

The tendency to make research directly prove pet theories, find short cuts to health, and cure diseases hitherto unsuccessfully treated will continue to give the investigator trouble for some time to come. What is needed is that at least a small number of scientists work at these problems of disease as we would at the other phenomena of the world around us. They should look them over from all sides calmly and objectively to get at the lessons expressed in them. They should look upon pathological manifestations as the normal sequences of causes operating under special conditions and for certain periods of time. They should endeavor to analyze phenomena rather than attempt to suppress or crush them. That function should belong to the health officer and the practising physician.

In order to take this calm attitude toward disease as a natural phenomenon and attempt to explain it, it may be necessary to move backward toward simpler problems from man to the higher animals, from these to lower types, from the complex processes of the human machine to the physical and chemical phenomena of the inorganic world. This has not always been the attitude of medicine, for standing as it does under the too near and impending shadow of suffering and death, it was but natural to attack the most difficult and complex problems first.

It is needless to say that the position of the research worker of the immediate future will not be an easy one. The strain to produce something is far more wearing than teaching. The mental play of the teacher's mind to produce something is relaxation compared with that of the investigator to carry out a contract for the delivery of new knowledge. The gap of years and even generations may yawn between the problem in hand and actual solution. It may indeed prove to be wholly impregnable from the point of attack. It may be solved by some obscure genius with slight facilities who happens to hit the combination which unlocks the secret.

We have all experienced the burden and complexity of growing information which has not reached the stage of actual knowledge. Extensive tables of figures are laboriously built up around it and the worker himself becomes encrusted and almost asphyxiated with methods and technicalities. We find the laboratory growing hot and stifling as we painfully add one more fact to the heavy burden. Suddenly and quite unexpectedly the true discoverer comes with a simple explanation. At his approach the air is cleared and freshened. Tables and figures are shoved to one side, and we begin our work once more with improved vision along another road.

Such is frequently the mission of the true discoverer, to leap over mounds of facts and figures, bring us back close to nature and show us that her movements are often far simpler than we dared imagine.

Thus far I have dealt with research as a thing by itself to be furthered by endowment and prosecuted by specially fitted men for the sake of its value to mankind. This is only preliminary, however, to the main thesis of our remarks, the training of research workers and the relation of research to the medical school. As a humble representative of the school which has provided so liberally in its new buildings for both research and instruction I must endeavor, amid the tangle of changing conditions, to place before you the relation between teaching and research as it presents itself to me.

I am quite inclined to make a sharp distinction between the physician and the investigator, and I think the time has come to create as it were a separate genus. What may be said of the type research worker should also apply to the teacher.*

Some enthusiasts would go so far as to urge that all students be made research workers. This is clearly uneconomical, for not many are fitted and the world has no use for many. There are needed chiefly well educated, humane, upright and patient workers who are ready to do the routine tasks of their profession. The physician must keep step with the great procession as it slowly moves forward. He can not deviate much to the right or to the left nor move much faster than the rest. His activities are more or less defined by a consensus of opinion. No matter how much he may swing his pinions in the laboratory, they will have but little room to move in the practical work of life. It is one thing to discover, and another to apply, one thing thoroughly to believe in our results, another to make others believe and act accordingly.

The research worker on the other hand deals more with the undefined boundaries of knowledge and with the frayed edges of sound information. He does not march with the procession, but he must do lonely outpost and scouting duties. He must seek clandestine meetings with those of other sciences, for he learns mainly by breaking through conventional barriers. He makes his discoveries unknown to others, and the farther they are in advance of the times the less attention they will receive.

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* The time is not so distant when it will become necessary to separate the functions of teaching and research. The teacher will then investigate to improve his teaching, the investigator will teach to clarify the aims of research. One merges insensibly into the other. The attempt to set apart the teacher and investigator is simply another tributary of the current which is tending to make all teachers independent of the practise of medicine, by urging adequate compensation for their entire time.

Again, the physician under the stress of practical life must be positive and aggressive in his dealing with disease. He must supply empirically what is lacking rationally, and his experience is therefore of the greatest value as it is in all vocations which couple science with actual life. The investigator, on the other hand, must be to a certain degree negative, skeptical of current theories, and suspicious of mere experience. He must frequently destroy before he builds up. He approaches the individual case of disease through general laws established through experiment. The physician must begin with his patients and through them reach general formulæ governing disease. He studies the patient, whereas the investigator studies the disease.

The investigator should be free to a certain degree to create his material and his problems. The physician must accept his cases as they come to him and he can only exercise the skill of selection. Each patient is indeed a problem, but it is worked out under the illumination of the accumulated knowledge of the world, and not dealt with according to strange and hitherto unknown formulæ. The physician can not control his patient excepting within a narrow range. Experiment as such, except when of a trivial nature, is forbidden by law and conscience. Statistics is the only court of appeal he has in attempting to prove success, and this method we know is open to serious error. On account of his peculiar and unique life work, the physician must build his education as broadly as possible and carry as much information as is compatible with normal thinking. The research worker, on the other hand, digs and delves and he must leave unnecessary encumbrances behind.

The main task of the medical schools will always be to train physicians. It does not fall within the scope of this address to define what this training should be, and I shall not attempt it, excepting in so far as it bears upon laboratory instruction. I believe that the medical school should make the future physician absorb as much as possible of the best medical science of the day and give him a certain initial skill and dexterity in carrying out the fundamental operations of the medical art. The power of the student to think independently, to digest the facts he has absorbed into some current theory which enables him to absorb more, and thus continually upbuild and rebuild his science, should be uninterruptedly stimulated by lectures, conferences and reading. To aid this constructive work laboratories have come quite generally into use. They are not research institutes at bottom, but originally a means to fix and illuminate through the senses facts otherwise meaningless. For the average student the laboratory is a review as well as a fixative of data which he is to carry with him and upon which he is to build his professional experience.

Those who are inclined to claim for the laboratory more than

this in the education of the physician, I would ask to consider how little of medical science can actually be presented there to the student. Certain functions can be demonstrated in physiology, certain processes and products in chemistry, certain anatomical facts and certain parasites as etiological factors in pathology. The prolonged impact of untoward conditions, the silent movement from health to disease, the shadowy boundary between the two who can adequately demonstrate them in the laboratory. There the days, months and years of disease processes must be concentrated into minutes and hours. Much of the laboratory work is like the ward visit, a fragment, to be pieced out through the agency of books, lectures and the imagination.

I am of course fully aware of the great importance of thoroughly training the senses and the powers of observation. The chief means of communication of the physician with his patient is through the medium of the senses, and the more avenues of intercourse are opened between him and the diseased body by increased delicacy of sense perceptions and by instruments of precision which aid and control the sense impressions, the more precise the diagnosis.

Lest I be misunderstood, I wish to emphasize the importance of bringing the student who is to be the future practitioner in as close contact with laboratory research and its immediate fruits as possible. For he will be the one to apply new points of view, gained experimentally, in the prevention and treatment of disease. Unless he gains some confidence in the laboratory and its methods and is ready to welcome its fruits how can medicine make any progress? His own contact with the laboratory should be for him a strong support and create in him faith in the ultimate triumph of science over the problems and mysteries of disease. Its influence should reach far beyond his years of training. When in practice he is disturbed by the confusion of voices, which, like the will-o'-the-wisp, lead neither here nor there, or when he is perplexed by the movement of fads and fashions pointing now in one, now in the diametrically opposite direction, when he comes to realize that much of his professional work is still empiricism and that it moves from precedent to precedent, he will look back upon his best laboratory work with a feeling of relief and recognize in it the germs of the science of medicine where his results came true if he worked accurately, and where he could predict the outcome. This power to predict which characterizes science should stimulate the trained physician to urge on in every way his profession toward the scientific ideal. If the laboratory succeeds in creating a desire to aid in realizing in the student this ideal its work will be well done. This craving to place his profession on a more and more scientific basis will lead to steady intellectual growth and insight and a proper receptive attitude toward the progress of science.

Much confusion can be avoided, I think, by classifying laboratories into two categories, those that inculcate principles of medical science and those which subserve clinical diagnosis. In the latter, clinical medicine or medical practise seeks to lay hold of the acquisitions of experimental science and to utilize them in the interpretation of symptoms. The clinical or hospital laboratory approaches medical problems from the professional side and is thus an extension of medical practise into a territory where science and practise meet and shade into one another. Here the future physician should receive most careful training when he begins to direct his studies toward some branch of medicine. For this important stage the Harvard Medical School has left the fourth year open. In this year the student should utilize all possible means of combining his practical training with the more analytic methods of the laboratory and exploit whatever it may offer in more accurate methods of making and recording observations. At the same time, we must not make the mistake of calling this research. It may later on shade into research, but it is at first simply increasing and perfecting the means of identifying already well-known disease processes.

We are just now passing through a period of reaction against so-called book learning which is likely to lead us too far in the other direction. So much weight has been placed upon the training of the senses that we are in danger of neglecting the mind behind them. It is vaguely assumed by some that laboratory work is *per se* research. This is far from the truth. We might with profit carry on researches in the published work of others without entering the laboratory. We might, on the other hand, spend our whole life in a laboratory without acquiring more than a little manual and optical dexterity. We are in danger of forgetting that the training of the observational powers is simply developing another language made necessary by the expansion of medicine as a biological science. The true investigator may have but imperfectly trained senses, but he may still succeed in discovering and opening up a new country to us. With his intellectual power to grasp and arrange data, largely worked out by others perhaps, he finds his way through the unknown.

In our zeal to further the educational methods of the day, there is just as much danger that we overload the mind with too many sense impressions, as with too many facts gathered through the medium of books. Have we not heard of the absurd waste of time in some laboratories over work employing laboratory technique which is as empty as the written page to many a student? Have we not seen many a laboratory servant whose senses were sharper than ours on occasion; many a butcher who detected abnormalities of the tissues more quickly than we? Yet they were not 'doing research.' Let us not deceive our-

selves concerning the true inwardness of research. It does not consist in trained senses alone. It is a quality, an attitude of the intellect working through the senses. Claude Bernard clearly recognized this when he said: 'He who does not know what he is looking for will not lay hold of what he has found when he gets it.'

Though research may be carried on and is going on in all departments of medicine to-day, yet the true home of the investigator is the modern laboratory. Here we have a kind of reproduction in miniature of the actual field of work, where, by means of physical, chemical and biological methods of analysis, the problem in hand may be reduced to as simple terms as possible or at least confined within more or less governable conditions. When it has reached a certain stage of maturity, then facilities should be at hand which enable the investigator to approach cautiously the very complex conditions of actual disease in the hospital and its special laboratories.

The university medical school has thus two duties to perform, to train practical men, physicians and health officers, and to encourage the few who incline to research. The methods of training for both coincide for a large part of the course, but they must eventually diverge, the practical man to enter the actual field of conflict with disease and forge his weapons as well as he can from the storehouse of the world's accumulated experience and science, the investigator to continue his struggle with the stubborn and evasive facts of nature.

To carry out this program the university school must have teachers who are investigators, well-equipped laboratories both for large classes and for individual advanced workers. It must have satisfactory stables and operating rooms for small and large animals, for the experimental and observational study of animal diseases is the logical outcome of laboratory research. It is another intermediate station on the way to human pathology. It frequently presents such strikingly clear solutions of difficult problems and permits us to introduce the comparative method which has been so fruitful in the biological sciences. Closely associated with the school should be hospitals and clinical laboratories. Let us look at a few of these requisites very briefly.

The training and encouragement of research as well as thorough teaching in our medical schools lead by implication to the doctrine that professors should be investigators themselves. For the purpose of elementary class work it may be maintained that it is enough for teachers to instruct with the aid of all the paraphernalia of the day. But what shall they teach? Shall they go no faster than the successive editions of text-books allow, or shall they express an opinion about or actually teach the newest doctrines? As I stated before, the knowledge of the world is covered with the froth of research fermenta-

tion of several years' depth, and the latter yields about as much genuine knowledge as the froth does actual fluid. The teacher can not well sound its depths unless he has made some independent studies of his own. Then he will be able to say something definite, whether he has been at work in this very field or not. His critical view will enable him to take sides and be positive rather than negative in his teaching.

It will no doubt be maintained by many that to teach undergraduates the latest information is out of place or at any rate not necessary. All that they need for their daily subsistence pertains to fundamental conceptions. But I answer that we really know little of fundamental conceptions and what we believe we know is being affected and modified by every new discovery of any value. It is of the utmost importance that the theories which the graduate takes with him be as sound and withal as fresh as the teacher can make them, for they will form the scaffolding of his thinking for some time to come, possibly for many years.

The teacher who is called upon to direct the work of students who are beginning to feel their way into unknown territory or who have already left the beaten path far behind must of necessity be an investigator. Without going ahead of them himself his counsel is apt to be wavering and at times he feels himself wholly helpless to advise. In other words, to direct research the teacher must be playing the chief part while his students, of whatever rank, should take subordinate parts all definitely working toward a given end. Only by such cooperative coordinated work can both the worker and the task become a success. The teacher's capacity for research is not necessarily measured by his productivity. This may be curtailed by his high standards of what should be put on record. At the same time his capacity for research should somehow make itself felt through those whose labors he is directing. His fruitfulness should be manifested through them. If a teacher remains sterile both in himself and his students he has missed his vocation.

Of importance equal to that of an efficient body of teachers are adequate laboratory facilities both for teaching and research. Medical science has moved beyond that stage when a student could be kept profitably employed with a microscope and a box of slides. With the growth of laboratory methods of diagnosis, more varied and costly apparatus is needed, more space to place it and more laboratory service to guard it.

In research the demands are similar, but more exacting in certain directions. Some still believe that abundant space and work room with cases full of the latest instruments will certainly lead to great discoveries. These are, to be sure, necessary; but without the

motive power behind them they are more than barren; they create the debts rather than the assets of research. This motive power consists of enough assured income to carry on research and develop the research powers of meritorious students. There should also be ample means for laboratory service. Research is in one sense a business, the laboratory a workshop. Here all sorts of processes are under way and as no one would expect a workshop to be carried on with only a foreman, so a laboratory can not be kept in use without laboratory service. Hitherto assistants have been made the motive power and the laborers; but this system should no longer be maintained. Not only is it wasteful to fill the time of assistants with routine manual labor, but it is wasteful in so far as the laboratory is dismembered at the end of each year. Every laboratory should be in working order even if all assistants are lacking. The trained laboratory servant should represent the routine and conservative, the assistants and investigators the progressive, element.

With the growth of the cost of research it becomes of great importance to exercise care and selection in admitting men to research positions. Fortunately there are not many collateral attractions in a life of research and the process of elimination acts as a rule automatically. Still there is danger just now that some of the flotsam and jetsam caught in an eddy or else afraid of the current of practical life may seek the quiet of the laboratory, because of some imagined taste or capacity which fails to materialize later on. It is far better not to have any research workers than poor ones.

The leaven of research which has so completely permeated and revolutionized all doctrines and practises of medicine in the past quarter century is still acting and no one can foretell how it is going to mold the medical science and practise of the coming decades. No one can foresee what it is going to do with the medical schools.

There will come without doubt much change in the artificial boundaries of the present so-called departments. Created for purposes of teaching and administration, they are a veritable bane to the investigator who can not stop mining because his vein happens to dip into another man's superficial territory. Even in the routine of teaching many changes are likely to come. I believe there will be developments in two main directions. The present laboratory studies, or propædeutics, will be deepened and extended in the direction of the more exact sciences, or toward the physical, chemical and biological work of the university proper. As a necessary result of this movement much of the work now done by these departments will move forward into clinical medicine and surgery, and there will be a corresponding growth and strengthening of the clinical and pathological laboratories of the hospitals. To illustrate: Much of what is taught

to-day in pathology belongs to clinical medicine and surgery, for it is largely special and diagnostic in character. The pathologist is now the servant of the physician and surgeon in completing and rectifying their diagnoses. The pathologist of the future will deal with more general phenomena derived from experimental and comparative data, just as the physiologist has moved onward, or backward if you please, into general and comparative physiology. Similarly, the burden of other now scientific departments will be shifted into the more practical branches to make way for more fundamental problems. The logical outcome of such a rearrangement of studies would be eventually a college course arranged wholly with a view toward medicine and sanitary science, in which the bulk of the present early studies of the medical school would find a place, and, secondly, a practical course in medicine, surgery and sanitary science, in which clinical, hospital and public health laboratories would take a prominent part. It may be that in this way the time and energy of the student aiming for two degrees and a livelihood could be saved, while the efficiency and scope of the course could be increased at the same time.

The establishment of research institutes by governmental authority and private munificence marked the beginning of a new epoch in medical science by organizing research and giving it an assured status. The influence of these institutes upon research in the university medical schools will be watched with much interest. Unless the latter take a more definite position and furnish opportunity whereby investigations of a more serious and exhaustive scope may be undertaken, the research institutes will absorb the best men and the highest class of work and leave research as heretofore a by-product of the schools, often desultory, discontinuous and trivial. To avoid this impending calamity, the professors should be relieved of various routine duties incidental to the management of laboratory workshops. There should also be appointed investigators of definite rank whose teaching should be subordinated to research in such a way that the latter will not be seriously impaired by long interruptions.

In conclusion I wish to dwell briefly upon a phase of our subject which is perhaps the most important of all and toward which the various lines of our discourse have been converging.

The relatively large endowments given to medical education and research in recent years have created as it were a trust to be administered by the medical profession in the interest of human society in the broadest and highest significance of the term. This I interpret to mean that we must endeavor to make all advance in our knowledge of health and disease common property so far as this may be possible, to disseminate broadcast the benefits of research into the laws of health, so that they may enter into and form an integral part

of the life of the individual and the community. We all know that much of the daily work of the physician goes to charity, that the public health authorities and sanitary officers are but scantily compensated for their arduous and often dangerous labors. There can be no question that as a profession medicine stands at the head in disinterested service; but there is still room for improving the relation between medicine and the public. How can this be done?

Perhaps, next to the education of physicians of the highest standards, the immediate duty of the university medical school is the development through research of preventive medicine and sanitary science and the education of sanitary officers. This, it seems to me, is the best way in which our debt to society can be discharged; for it is the way through which medicine has moved during the past quarter century to its present commanding position; it is, in fact, the way of least resistance for the human race to evade or mitigate the penalty incidental to advancing civilization. Preventive medicine is the application of medical science to the mass as well as to the individual. It attempts to arrest disease before its momentum has carried it beyond the means of help. It is the truly modern as contrasted with the medieval point of view.

Nobody will deny that much has already been done in the development of preventive medicine and sanitary science. It will be claimed, and with justice, that more has been done than the public is willing and prepared to accept and live up to. We know that to-day municipalities continue to permit the unnecessary sacrifice of lives to epidemic disease, that politics is permitted to disorganize efficient boards of health in large and small communities and to put the best material interests of family and social life into untrained hands. We know that the public continues, in spite of warnings, to consume noxious drugs, widely and boldly advertised in the daily press. These difficulties are very real, but they should not discourage us. The medical profession is in a sense to blame for this condition; for the household remedies and cures of to-day are those of the doctor of a generation ago, and the medical practise of to-day will crop out in the daily life of the next generation. Likewise, the indifference of the physician and health officer of a generation ago is reflected to-day in the attitude of the mass of the people.

The university medical school has here a great function to perform, for it is the legitimate source of knowledge pertaining to hygiene and sanitation. There are few problems which have not been suggested by contact with disease. Sanitary science is broad and rests upon many foundations, and the means of disseminating its teachings are many, but its origin is in pathology. Without the stimulus of the

continual presence of disease its problems may become trivial and its practise ineffective.

The university medical school may in still another way hasten the diffusion of sounder views concerning health and disease by creating more interest among the educated in the general problems of pathology. This is but the obverse of physiology, and its principles once scientifically founded and objectively developed along general and comparative lines, should form an attractive study in all biological laboratories. We are still some distance from the realization of this suggestion, but the task is worthy of the best men in our best schools.

If we take this broad view of the work of the university medical school and try to put it into effect, medical science will come out of its somewhat isolated position and take its proper place beside the other sciences. The work of the physician will then be rated more justly, because the great complexity of the problem of health and disease will be more appreciated. His services will then be sought more frequently before rather than during the calamity of illness, because it will be better understood why he can more easily forestall and prevent than cure disease.

THE PROBLEM OF IMMIGRATION.

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AS has been pointed out, the extension of our immigration inspection service to the Canadian and Mexican frontiers, and the splendid work done on the border by the immigration officers, have closed the last gateways open to violators of our immigration laws. Not only are the laws enforced rigidly at United States ports and border towns, but by agreement with the Canadian steamship authorities, American officers are stationed at Quebec, Montreal, Halifax, St. John and Victoria, B. C., for the inspection of immigrants destined to the United States through Canada. Our present immigration laws are effective against many of the most undesirable classes of immigrants and our immigration officers by their vigorous enforcement of these laws have acquired a reputation in Europe which has a deterrent effect upon the undesirable classes. Every defective alien deported to Europe advertises the fact that we will not permit 'paupers, diseased persons or persons likely to become a public charge' to land. But the law at present is ineffective as applied to the class usually referred to as 'persons of poor physique.' They are admitted because it can not be shown definitely that they are 'likely to become a public charge.' They have friends, perhaps, who live in the city and vouch for their ability to earn a living, or their skill in a sweat-shop occupation is accepted as evidence that they will not become dependents.

In the immigration question, two great problems present themselves, the separation of the undesirable from the desirable classes, and the distribution of our landed immigrants. President Roosevelt in his message to the Fifty-eighth Congress, December, 1903, with characteristic directness, strikes to the heart of the question, and gives the following concise expression of its problems:

> We can not have too much immigration of the right kind, and we should have none at all of the wrong kind. The need is to devise some system by which undesirable immigrants shall be kept out entirely, while desirable immigrants are properly distributed throughout the country. At present some districts which need immigrants have none; and in others, where the population is already congested, immigrants come in such numbers as to depress the conditions of life for those already there.

This brings us to the question of what constitutes a desirable immigrant. The first requisite of a desirable immigrant is good physique.

Without a robust constitution and average physical strength, the immigrant can not cope successfully with the hardships which he will be called upon to endure in his new home. The immigrant of poor physique is not able to perform rough labor, and even if he were able, employers of labor would not hire him. The large employers of labor expect and demand men physically strong enough to do a fair day's work. The only place where the immigrant with a poor physique can make a living is in the large city, where he becomes either a parasite or a competitor of American skilled labor. The unfair competition of this type of immigrant can be better understood if one takes into consideration his standard of living and the system of sweat-shop production.

There is no longer demand for foreign skilled labor in the United States. Skilled labor in its ratio to unskilled labor among Americans has steadily increased until now the American skilled laborer can supply every demand, and each foreign skilled laborer who comes here comes as a competitor of our own workmen. On the other hand, the demand for unskilled labor is increasing in proportion to the decrease of American unskilled laborers. This demand will continue until our present industrial and commercial expansion ceases. New lands are opened up by settlement or by irrigation. Intensive methods of farming make possible a great increase of rural population, and this agricultural expansion creates an increased demand for manufactures. Thus our industrial and agricultural expansion progress side by side, and for this progress we must have plenty of brawn and muscle—unskilled labor. Americans can fill the requirements of the skilled laborers and mechanics, but if capitalists had to depend on native Americans for the unskilled labor necessary for their projects, these projects would never be carried to completion, or, if attempted, would be certain of financial failure.

The introduction of improved machinery, with its enormous effect upon our power of production, made necessary increased numbers of unskilled laborers and without these sturdy workers the use of machinery would not be successful financially or otherwise, and we should retrogress to the position of manual production which we occupied twenty-five years ago. Immigration and machinery are both charged with displacing American labor and depressing wages, but they are simply new forces demanded and made necessary by the expansion of our industries. To prohibit either is to paralyze industry, to stand still as a producing power, and to stand still is only the temporary pause before retrogression begins. Commercial prosperity is simply this expansion of industry and trade consequent upon the development of new resources. This development is the result of capital invested. Capitalists before investing invariably demand assurance that sufficient labor is forthcoming to carry out the proposed work, and that the compensa-

tion of such labor will be compatible with its financial success. If this assurance can not be given to capitalists, they will not invest, industrial expansion ceases, and the wages of the American workers, as well as of the aliens, suffer from general business depression.

In order to be a desirable immigrant, the type of immigrant represented must be necessary. As skilled alien laborers are no longer necessary, they can scarcely be classed as desirable. The necessity for the unskilled laborer will be conceded by those who take the trouble to study economic conditions.

The aliens of poor physique, who are usually skilled laborers, go to the crowded city, to the dark, poorly ventilated and disease-infected tenement. The thousands of these city dwellers arriving every year perpetuate the tenement house problem, and retard the work of sanitation and reform.

Of remedies proposed for the further exclusion of undesirable immigrants, three are worthy of consideration: (1) Raising the head tax, (2) an illiteracy test, (3) a definite standard of physique.

Raising the head tax to 100 or 150 dollars is suggested by some as a means of restricting immigration. This procedure is open to serious objection for several reasons. It would not be selective in its action. It would bar all classes, good and bad, indiscriminately, and would be almost prohibitive to the races with the best physique and highest percentage of unskilled laborers. In case of those who come here as home-seekers and who are able to pay such a tax, it would deprive them of a sum of money which would be of great value in their struggle, and much needed at the very outset of their new life. The imposition of such a tax is a weapon of defense which might be used in the event of great danger from immigration, owing to absence of demand for labor here, but that possibility seems remote and this high head tax must be considered as a last resort, not likely to be needed. A moderate head tax will probably be the rule for the next few years. The present head tax of two dollars may be raised to five or ten dollars in order to restrict the volume of immigration, if, in the opinion of our lawmakers, restriction of the quantity as well as the quality of our immigrants is necessary. Any head tax moderate or high can operate only as a numerical restriction and can not be expected to regulate the quality of immigration.

In order to appreciate fully the effect of barring illiterates, it is necessary to consider the proportion of illiterates in each of the principal racial factors of our immigration. Consideration must also be given to the percentage of unskilled laborers furnished by each of these races, because, although the illiteracy amendment is intended to exclude the parasitic city-dwelling immigrant, it affects as well a large proportion of the races furnishing us with the bulk of our necessary unskilled labor.

The following table indicates the ratio of unskilled laborers to the total landed in 1903, also the percentage of illiteracy; only those races whose illiteracy is above 10 per cent. are given:

Race.	Total Number Landed.	Number of Unskilled Laborers.	Ratio of Unskilled to Total Landed.	Ratio of Illiterates.
South Italian.....	196,117	118,000	59 per cent.	48 per cent.
Pole	82,343	51,000	63 " "	32 " "
Croation	32,907	26,850	81 " "	35 " "
Slovak	34,427	21,400	62 " "	22 " "
Ruthenian	9,843	7,300	73 " "	49 " "
Lithuanian.....	14,432	9,550	66 " "	47 " "
Greek	14,376	9,700	68 " "	28 " "
Syrian.....	5,551	1,900	34 " "	54 " "
Hebrew.....	76,203	7,000	9 " "	26 " "

The first race (Italian) and the last three races (Greek, Syrian and Hebrew) given in the above table are notoriously city dwellers. The Italian and five races immediately following, Pole, Croatian, Slovak, Ruthenian and Lithuanian, furnish us with nearly all our unskilled industrial labor.

While it must be admitted that the illiteracy test would debar many thousands of undesirable immigrants and prospective dwellers in the tenements, it is doubtful if this result would compensate for the loss of 32 per cent. of such sterling laborers as the Poles, or 35 per cent. of the Slavs in general, in view of the fact that as large, if not a larger, proportion of the undesirable immigrants could be debarred by requiring a high standard of physique, without seriously affecting our supply of unskilled labor. The standard of physique should be definitely prescribed by law, so that the medical certificate of failure to reach the standard would be final, as it is now in loathsome or dangerous contagious disease, idiocy, epilepsy or insanity.

The standard required of recruits for the United States army, with a fixed minimum height and chest measurement, could be employed for this purpose. Every male immigrant between the ages of 18 and 45 should be required to pass such a physical test. Each family should be required to possess at least one male, supposedly the bread winner, who could come up to these requirements.

An aged person, if unaccompanied, should not be permitted to land, unless he or she possess a son, daughter or other near relative in America, who is willing and able to care for such aged dependent. This physical standard to be required of the persons specified in addition to, and not in place of, such other restrictions as are now in force. The requirement of a high definite standard of physique would have very little effect upon the most desirable alien races. It would fall heavily upon the parasitic and competitive classes, and, while it would not stop all the yearly alien reinforcement of the foreign quarters and

slums, it would at least ensure that the reduced number of additions were of a physique rugged enough to withstand the influences of such an existence. It would not materially reduce the number of agricultural and industrial unskilled laborers and would permit the admittance of plenty of men physically able to do a fair day's work for their employers.

In the matter of distributing aliens over a wider area, two distinct classes must be considered, the aliens already established in colonies in our cities, and aliens in general who, through ignorance of opportunities offered in different sections of the country, in many instances go to the congested areas rather than to the places where their labor is needed. No plan for the relief of tenement congestion, by better distribution of aliens already established there, can be successful without a reduction of the number of yearly steerage arrivals, particularly of those classes which tend to congest the cities. Many schemes for the distribution of the aliens congregated in cities have been proposed; some are chimerical, others more practical, but the consensus of opinion among philanthropic individuals and representatives of charitable societies is that the process of distribution is necessarily a slow one. The city-dwelling immigrant must be here some three or four years before he knows enough of our language and customs to enable him to be self-supporting away from his own race. It seems also that distribution must be effected individually rather than by colonies. The experience of the great Hebrew charitable societies at least bears out this view. Their efforts at wholesale rural colonization have almost in every instance failed, and the colonies established with few exceptions required the paternal aid of the society constantly. On the other hand, the same organizations have distributed several thousand Jews, who have been here some time and have learned something of American ways, in various parts of the country, and these have been almost uniformly successful. As has been said, some of the Hebrew colonies, which were failures as farming communities solely, were made self-supporting by the introduction of clothing factories. The establishment of such industrial colonies is of distinct service in relieving the congestion in the cities, and should be encouraged in spite of the claim made by some that the competition from the rural shop is ruinous to the clothing trade. From all that can be learned the clothing industry in New York can sustain its own low standard in competition with any number of rural shops.

When one considers how slowly the work of distributing the excess alien population of the tenement districts goes on in spite of the best effort of societies, individuals or municipal officers, the necessity is at once apparent either to stop altogether the annual reenforcement of this tenement population, or, at least, so reduce the number of addi-

tions that the work may make some progress. As it is now, the good work done each year by charitable organizations and by philanthropists goes almost for naught. The splendid work of the New York tenement house and street cleaning departments is nullified to a large extent by the yearly addition of thousands of these alien tenement dwellers, for whom the tedious work of education in sanitary matters must be repeated from the beginning.

In regard to aliens in general, whether they desire to live in the city or in the country, many believe that something should be done at the port of arrival to educate them in the resources and opportunities which exist in various states. The commissioner general of immigration, in his annual report for 1903, recommends that Congress appropriate a sufficient sum to establish information bureaus at the various ports of entry, located in suitable buildings where exhibits can be shown and information given to arriving aliens by government or state officers. Such information would enable the immigrant to locate where his labor was needed and where the best opportunities were afforded for making a home. This plan seems feasible and, coming from such a high source, is worthy of thorough trial. The commissioner-general, in the strongest terms, urges legislation to establish these information agencies, with or without the cooperation of the states, not only because of the need of the immigrant's labor in certain sections, but also because of the good effect upon the alien.

After all, these two problems of exclusion of undesirable immigrants and distribution of aliens are closely associated. The class that clings most persistently to the crowded city is an undesirable class. And if, because of its poor physique, the majority were excluded, as it would be if we had a definite standard of physique, our problem of distribution would be very greatly simplified.

It is scarcely necessary to refer again to the baneful influence exerted by the congested tenement areas, both upon the immigrant and upon the body politic. Here the immigrant receives false ideas of personal freedom and political privilege and a distorted impression of our whole political system. Moral deterioration is a certain accompaniment of life in the slums, and physical degeneration is still more marked. His occupation is parasitic in character or at best competitive from a standard far below that compatible with decent living. And while this deadly struggle for existence is being waged by the immigrant in the city, the farmers south and west can not procure enough labor to harvest their ripened crops. What a different story could be told of these poor aliens of the tenement could they be directed to the proper sphere! Removed from the temptations which surround them in the city, from the depraved examples of slum life which everywhere confront them, they would find in the country the healthy, moral stimulus of contact

with the soil. The demoralizing effects of over-crowding in the city would be neutralized by the pure air and invigorating influence of an outdoor life, and best of all, instead of being a diseased growth upon society, they would become producers, and each one would add his share to the sum of our country's wealth. Instead of absorbing false ideas of sociology and politics, the rural immigrant would have the opportunity of studying that bulwark of our institutions, the American farmer. What a different influence the honest, conservative farmer must exert over the alien immigrant from that of the ward boss of the city! How infinitely better as an example of citizenship for the foreigner's emulation!

Improved agricultural implements have removed much of the drudgery from the farmer's life. A profusion of good newspapers and magazines keep him in touch with the world, and his isolation is greatly reduced by the omnipresent telephone and trolley car. The rural mail delivery and the movement for better roads promise to reduce still further his isolation in the future. Thus the country will become not only more attractive to the inhabitants of rural communities, but it will also appeal more strongly to city dwellers. The present exodus of farmers' sons and daughters from the farms to the great cities will diminish in size, and the number of city-dwelling aliens migrating to the country will increase. In this great work of equalization of population many forces will combine and render mutual aid. The attractive features of the various parts of the country where labor is needed can be shown to the alien in many ways. Philanthropic societies and individuals are doing much at present and will do more in the future. The great railroad companies have a common interest with the various states, where the alien is needed and welcome, in distributing the alien and developing those states. The federal government can best combine and harmonize these forces by inviting their cooperation and furnishing an exposition building, as recommended by Commissioner-General Sargent, where the advantages offered by various sections of our country can be exhibited to the immigrants.

AGE AND EMINENCE.

By Professor EDWIN G. DEXTER,
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SELDOM has the popular mind been so deeply moved by the casual utterance of a savant as in the recent instance of Dr. Osler's now famous valedictory at Johns Hopkins. Nothing was probably more foreign to the speaker's mind than an intention to stir up the tumult of newspaper contention that followed his remarks, and we may presume that he is not altogether pleased at the exact character of the notoriety which he has achieved. The portion of his address that has brought him so prominently into the public eye had to do with the age of greatest usefulness in man, and runs as follows:

I have two fixed ideas, well known to my friends, harmless obsessions, with which I sometimes bore them, but which have a direct bearing on this important problem. The first is the comparative uselessness of men above forty years of age. This may seem shocking, and yet, read aright, the world's history bears out the statement. Take the sum of human achievement in action, in science, in art, in literature—subtract the work of the men above forty, and while we should miss great treasures, even priceless treasures, we should practically be where we are to-day. It is difficult to name a great and far-reaching conquest of the mind which has not been given to the world by a man on whose back the sun was still shining. The effective, moving, vitalizing work of the world is done between the ages of twenty-five and forty—these fifteen years of plenty, the anabolic or constructive period, in which there is always a balance in the mental bank, and the credit is still good. . . .

My second fixed idea is the uselessness of men above sixty years old, and the incalculable benefit it would be in commercial, political and in professional life if, as a matter of course, men stopped work at this age. Donne tells us in his 'Biathanatos' that, by the laws of certain wise states, sexagenari were precipitated from a bridge, and in Rome men of that age were not admitted to the suffrage, and they were called *deponati*, because the way to the senate was *per pontem*, and they, from age, were not permitted to come hither. In that charming novel, 'The Fixed Period,' Anthony Trollope discusses the practical advantage in modern life of a return to this ancient usage, and the plot hinges upon the admirable scheme of a college, into which, at sixty, men retired for a year of contemplation before a peaceful departure by chloroform. That incalculable benefits might follow such a scheme is apparent to any one who, like myself, is nearing the limit, and who has made a careful study of the calamities which may befall men during the seventh and eighth decades.

The thoughts expressed in these paragrpahs were much more fully elaborated by Dr. Osler in the delivery of his address, and we may

accept them as the basis of the controversy. It is plain that in the discussion of the second of the 'fixed ideas' the allusion to Trollope and the use of chloroform for the sexagenari was a bit of pleasantry and not intended by the speaker to be taken seriously. It has, however, proved too subtle for many a yellow sheet.

Yet it is just as plain that Dr. Osler in all seriousness believes that man's constructive period reaches its climax and begins to decline by the age of forty years and also that the world would be the gainer if all active participants in its affairs were at the age of sixty replaced by younger men. He does not, I take it, contend that men above that age are absolutely useless, but only relatively so. That is, for every man in service above the age of sixty, a better man could be found to take his place below that age. In considering this proposition it is inevitable that men, such as Gladstone, Bismarck, Moltke, Hoar, Rockefeller, Morgan and scores of others beyond the age limit, leaders in various activities, come to mind as refutations of his theories. Yet we must not forget that, according to the census, 6.4 per cent. of the inhabitants of the United States, or 4,871,861 persons, are beyond the age of sixty years, and that instances of aged leadership are comparatively rare—perhaps sufficiently so as to give some support to Dr. Osler's contention.

But it is the former of Dr. Osler's 'fixed ideas' that I wish primarily to discuss, the one expressed in the words that 'the effective, moving, vitalizing work of the world has been done between the ages of twenty-five and forty. We can not doubt that large numbers of thinking people are roughly of his opinion. Many corporations refuse to add to their working forces persons beyond the age of forty years, and a question recently taken up for serious discussion before a national body of educators was whether teachers did not as a class depreciate in effectiveness after the age of thirty-five.

It is not, however, through the expression of personal opinion that I can hope to add anything to the question, but through recourse to a considerable mass of data that I happen to have in my possession showing the age at which some thousands of Americans have received public recognition for services rendered. I refer to those mentioned in 'Who's Who in America.' Some years ago in connection with a study the purpose of which was to determine the educational preparation of those who had achieved the kind of eminence which mention in that book indicates, I made a tabulation of the ages of the nearly 9,000 persons mentioned in the edition of 1900. The names fell quite naturally, so far as vocation is concerned, into two twenty-five groups, the greater number of which—for men only—are given in the following

table, together with the number in each group, the median age of the group and the percentage of persons under the age of forty years.*

Profession.	No. in Group.	Median Age of Group in Years.	Percentage Below Forty. Years of Age
Actor	54	48	20.3
Artist	260	44	14.5
Author	528	54	19.4
Business man	200	63	2.5
Clergyman	655	59	5.5
College professor	1,090	47	22.0
Congressman	446	53	14.6
Editor	509	47	20.0
Educator	188	54	21.8
Engineer	284	55	9.8
Financier	215	64	5.5
Inventor	26	62	0
Lawyer	857	57	5.6
Librarian	362	50	22.6
Physician	540	56	11
Musician	111	44	33.3
Sailor	103	59	5.0
Scientist	146	44	31.3
Soldier	205	63	6.8
Statesman	202	55	8.0
	6,983	Av. 54	Av. 16

Although this table has a bearing upon the minimum age at which a certain sort of public recognition is given to achievement, in its consideration two things must be borne in mind; first, that many of those who were at the issue of the book over forty years of age performed the service which gave them prominence before they had reached that age; and, second, that there must always be something of a lag in public recognition, and in all probability many who had already performed service of importance had not yet been promoted to the ranks of 'Who's Who.' Yet, even with these qualifications, the figures are not without their bearing upon the question of the minimum age at which important public service is rendered, for without doubt achievement of the first rank is not slow of recognition. And the thing which must strike one most forcibly in any inspection of the table is the comparatively few men under forty years of age. Of the 6,983 men, the median age is fifty-four years, while but 1,118, or less than one in six, were below the age of forty years. Stated in other words, this means that in the year 1900 out of a group of nearly 7,000 eminent men but 16 per cent. were within Dr. Osler's age period of most 'effective, moving, vitalizing work.' Although this fact can not be taken as disproving his conten-

* The persons mentioned in the volume but not included in the group studied either formed a nondescript class so far as vocation is concerned or failed to give the date of birth, or were women and were tabulated separately.

tion, since, as has been said, a considerable number of the older men may have completed their important work at an early age, still it would seem to throw some serious doubts upon the truth of his generalization. At least the figures show that in a group of arbitrarily limited extent, *i. e.*, the size of 'Who's Who,' the young man in competition for a place is but a one to five 'shot.' But it is possible, through recourse to mathematics, to indicate approximately the age at which the service was rendered which secured admission to the book. To illustrate—of the entire number of 6,983 comprising our group, 86 were between the ages of twenty and twenty-nine years, the entire number having become famous during that decade of life. The probable mortality of that number of persons for the decade, supposing them to be good 'risks,' would be six. We may then suppose that 80 would enter the next decade. But our figures show that 922 of our entire group were between the ages of 30–39, inclusive, leaving the number 842 as representing the number of new names admitted during the decade. Of the total number for this age period (922), the mortality tables lead us to suppose that 78 will die before its completion, giving us 844 as the number passing on to the next group—that for the age decade of 40–49 years. Again we get the probable number added during the decade by subtracting the number thus admitted from the previous group, from 1,620, the total number of persons of the age covered by the decade and find the total number added for services rendered during the decade to be 776. In the same way, by using the continually increasing mortality rate and applying it to the number left over from previous decade-groups, we find the number added between the years 50–59 to be 376; from 60–69 years, 51. Beyond this point the computation gives us minus quantities for the number of persons admitted during each of the next three decades, indicating seemingly either or both of two conditions; first, that the mortality among these men of eminence is greater than that of the insurable risks upon which the mortality tables are based; second, that in the compilation of 'Who's Who,' the old men did not receive the recognition given to their younger confreres, thus reducing the size of these more advanced age-groups. Either one of these conditions would tend to bring about the statistical result alluded to, and on consideration we have reason to believe that both of them are active.

If the above reasoning is not fallacious, and if there is no great lag in the public recognition of achievement, we have a further refutation of Dr. Osler's contention that the 'work of the world is done between the ages of twenty-five and forty,' for we find the ratio of recognition for the several decades to be as follows:

20–29	30–39	40–49	50–59	60–69
3.9 per cent.	39.5 per. cent.	36.4 per cent.	17.6 per cent.	2.4 per cent.

From this we see, that although the decade from 30–39 shows the greatest productivity, it is but slightly greater than the next succeeding one, and that less than one half have made good—at least so far as public recognition is concerned—before the age of forty years.

Although these generalizations are for the whole group studied, irrespective of vocation, the first table shows considerable differences in the average age of those in the various professions and also in the percentages of those under forty years of age. This question was discussed by the author in the POPULAR SCIENCE MONTHLY for July, 1902, but I take the liberty of touching upon it briefly again.

It is noticeable that the musician distances all competitors in the race for distinction. This is not hard to understand when we recall the infant prodigies who frequently figure on our bill boards, or consider that nature has in most cases contributed more largely to his success than has nurture. Of those callings which presuppose a professional or at least an extended preparation, that of scientist seems from our table to promise the earliest recognition. This is perhaps due to the fact that with him the actual work of life is entered with a completer intellectual equipment than by most of the others, and that the period of preparation offers opportunities for research and original investigation which may bring renown even before life work is begun. This would also apply to the college professor with perhaps fully as much force and in a lesser degree to the librarian and the educator. These four then might be included in a class in which the period of preparation is extended, but for which work of a high order might be expected immediately on its completion and positions of some prominence aspired to from the start. Next in the race for renown come the actor and the author, almost neck and neck. If we conclude that nature had most to do with the musician's success and nurture with the educator's, we should be forced to place the author and the actor in a class in which these two forces divide the honors more evenly. No doubt one must be born an actor or an author to rise to a high rank, but after all, the making process is not to be despised as a factor, and this takes time. Except for the soldier and sailor, whose ability to rise to prominence, at least in time of peace, is determined by the rapidity with which those above him are retired from service, and the congressman and the statesman, whose minimum limit is prescribed by law, the rest of the vocations shown upon the chart fall, it seems to me, into a class for which the schools, as organized means of education, provide no adequate preparation, and for which that preparation must come to a great extent from the vocation itself. Thus the scientist, or even the college professor, who has devoted thirty years of life to study, can enter his profession from the top,

while the business man and financier for whom the accumulation of wealth is a desideratum, or the lawyer and the doctor who must command a practise, or the minister who needs a congregation, must with the same period of intellectual infancy enter it from the bottom and devote a few more years to the climbing process. In so far as the physician is an investigator, the conditions of the scientist apply to him, and no doubt the considerable number who are such accounts for the fact that his recognition comes earlier than that of his competitors in law and the pulpit. The surprising thing of the figures is perhaps the slowness with which the inventor gains a foothold in the ladder of fame. Not one of those mentioned was below the age of forty years, though the group is too small to give this fact much weight.

Although women are not included in the table given, the study of those mentioned in 'Who's Who' shows that upon the stage and in musical circles recognition is much earlier for them than for men, while in all other callings it is slower. This would seem to suggest that attractiveness of person is at a greater premium with her than with her brother, and perhaps makes up for some other defects. When however this is outlived with youth, the struggle seems to be a hard, if not a losing one.

AUTHORITY IN ENGLISH PRONUNCIATION.

By Professor EDWIN W. BOWEN,
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FOR wellnigh two centuries a popular belief has prevailed throughout the English-speaking world that there should be a standard of pronunciation, which should be followed in all those countries where English is the native tongue. Many people, holding this view, assume that some such norm is unconsciously observed by men of education and culture, who, because of their influence and rank, are generally conceded the right to establish the customs of speech. It is but natural, therefore, that men with greater or less claim to culture and education should take it upon themselves from time to time to determine the supposed standard of pronunciation. Thus as far back as the beginning of the eighteenth century we find that the orthoepists of that period undertook to ascertain and record the pronunciation of English as practiced in polite society.

Now, the early orthoepists discovered, apparently to their astonishment, that English pronunciation, even in the most cultured circles, far from being fixed by ironclad rules, was quite an elastic thing, allowing considerable latitude. Indeed, two centuries ago pronunciation in English, as reflected by the best usage, was no more uniform than it is to-day. Then as now, men recognized no fixed and absolute standard of English pronunciation. They followed their own tastes and individual preferences, despite the orthoepical suggestions and recommendations of their contemporaries. Prejudice and caprice, too, in those days, as in the present time, were factors to be reckoned with, so that the path of the would-be authority on pronunciation was beset with no slight difficulty.

It must not be inferred, however, that the orthoepists themselves were a unit and in perfect harmony as to current usage. On the contrary, they were frequently far apart in recording the pronunciation sanctioned by the best society and differed quite as much as their worthy successors of the present day. They sometimes indulged in vituperation and severe censure at each others' expense and made no attempt to conceal their disapproval of a rival's authority, which they expressed in plain, vigorous Anglo-Saxon. Some of their sarcastic remarks furnish spicy and entertaining reading to the student who is willing to plod his way through the dreary waste of those forgotten dust-covered tomes.

The most conspicuous among the eighteenth century orthoepists were Baily, Johnson, Buchanan, Sheridan and Walker. Some of these were Scotch, and some Irish, and some, of course, English. Quite naturally it struck the fancy of an Englishman as somewhat humorous, not to say absurd, for an Irishman or a Scotchman to pose as an authority on English pronunciation. So the damaging taunt of foreign nationality and consequent lack of acquaintance with English usage was flaunted in the face of Buchanan and Sheridan, natives of Scotland and Ireland, respectively.

When Doctor Johnson was informed of Sheridan's plan of producing an English dictionary that was designed to indicate the pronunciation of each word, he ridiculed the idea of an Irishman's presuming to teach Englishmen how to speak their native language as utterly absurd. "Why, Sir," growled the autocrat of eighteenth century literature, "my dictionary shows you the accent of words, if you can but remember them." Then on being reminded that his dictionary does not give the pronunciation of the vowels, "Why Sir," continued he, in his characteristic surly manner, "consider how much easier it is to learn a language by the ear than by any marks. Sheridan's dictionary may do very well; but you can not always carry it about with you; and when you want the word, you have not the dictionary. It is like the man who has a sword that will not draw. It is an admirable sword, to be sure; but while your enemy is cutting your throat, you are unable to use it. Besides, Sir, what entitles Sheridan to fix the pronunciation of English? He has, in the first place, the disadvantage of being an Irishman; and if he says he will fix it after the example of the best company, why they differ among themselves. I remember an instance: when I published the plan of my dictionary, Lord Chesterfield told me that the word *great* should be pronounced to rhyme to *state;* and Sir William Yonge sent me word that it should be pronounced so as to rhyme to *seat,* and that none but Irishmen would pronounce it *grait.* Now, here were two men of the highest rank, the one the best speaker in the House of Lords, the other the best speaker in the House of Commons, differing entirely."

As this quotation shows clearly and forcibly, even the usage of the very best speakers in England in the eighteenth century was far from uniform and harmonious, as has been intimated in the opening paragraph. Moreover, it is evident from the striking illustration Johnson uses that English pronunciation must have varied much more two centuries ago than it does to-day; for no two speakers of national reputation, such as the leaders of the two chambers of Parliament presumably must have been, would differ so radically at the present time in their pronunciation. The truth is, in those good old days men paid but little attention either to pronunciation or to spelling. It is a

fact not so widely known as it deserves to be, that English orthography two centuries ago was just emerging from a state of confusion and chaos; and law and order were then for the first time beginning to appear. The result is the conventional spelling which only since the eighteenth century has been stereotyped in the form now so familiar to all educated people. And not even yet, as we know, has English orthography had its perfect work. As late as Doctor Johnson's time, the spelling of many English words had not yet been crystallized, and not a few words could be spelled in two distinct ways, either of which was recognized as correct. For instance, the spelling of *soap, cloak, choke* and *fuel,* to select only a few examples, as recorded in his dictionary, vacillated between 'sope,' 'cloke,' 'choak,' 'fewel' and the present accepted spelling of these words. These variant spellings, long since rejected, now seem to us either attempts at phonetic spelling or quaint and curious imitations of Chaucerian orthography. Having discussed elsewhere* the subject of English spelling, I dismiss the matter here with this passing reference.

The crystallized form of English spelling which has been brought about mainly through the influence of the printing-press in the last few centuries we accept as a matter of course, little thinking of the difficulties innumerable which the printer and the 'gentle' reader encountered three centuries ago. But the very existence of a standard orthography, as a moment's reflection will show, has necessitated as its indispensable adjunct the pronouncing dictionary.

The pronouncing dictionary, therefore, is a modern production; it was hardly known before the first quarter of the eighteenth century. It is held by some scholars, notably Professor Lounsbury in his 'Standard of Pronunciation in English,' that the pronouncing dictionary was called into existence by the desire on the part of the imperfectly educated middle class to know what to say and how to say it. This desire became stronger and stronger as the members of that growing class of England's population rose by degrees into social prominence. Possessing little culture and few social advantages, and lacking confidence in their meager training, such people were not willing to exercise the right of private judgment, and consequently they sought out an authority and guide. They were eager to learn the modes of speech which obtained in the most highly cultured circles, the *jus et norma loquendi* of the nobility. It was natural therefore, since the occasion appeared to demand it, that self-appointed guides should come forward and offer to conduct the multitudes of social pariahs through the wilderness of orthoepical embarrassment into the Canaan of polite usage. Such was probably the origin of the pronouncing dictionary.

* See THE POPULAR SCIENCE MONTHLY, May, 1904, 'The Question of Preference in Spelling.'

It will prove interesting to consider some of the pronunciations authorized by the early orthoepists as reflecting contemporary usage. How unlike current usage many of those early pronunciations are, the reader will see for himself. But first a word as to the orthoepists themselves.

The earliest of the eighteenth century orthoepists is Baily. His dictionary enjoyed the enviable distinction of being the first authority on English pronunciation during the first half of the eighteenth century. But Baily's supremacy was eclipsed by Johnson, whose epoch-marking dictionary appeared in 1755. Johnson claimed to record the most approved method of English orthoepy, and his prestige as a man of letters contributed speedily to establish his dictionary as the ultimate authority on English pronunciation. It is to be observed, however, that Johnson only indicated the syllable on which the accent falls. This left much to be desired as a pronouncing dictionary. So, in 1766, Buchanan, a Scotchman, gave to the world his dictionary which challenged Johnson's pre-eminence. A few years later, in 1780, to be accurate, Sheridan published his dictionary. Sheridan was an Irishman by birth, as has been said, the son of the famous British orator and dramatist, Richard Brinsley Sheridan, whose plays are so favorably known to us through Mr. Jefferson's interpretation. Sheridan's nationality was used by his competitors to prejudice the public against his dictionary and to discount it as an authority on English pronunciation. Still Sheridan enjoyed a considerable vogue.

In 1791 Walker published his dictionary. The reputation of this work, in a revised form, extended far into the last century, so we are informed by the late Mr. Ellis in his authoritative work on English pronunciation. Walker, like Sheridan, was an actor, but unlike his rival he was an Englishman by birth. He did not fail to draw attention to the advantage this circumstance would naturally give him in the popular estimation, in advertising the merits of his book. In his treatment of the principles of pronunciation, however, Walker shows a feeble grasp of his subject, and the most serious criticism upon his book is that he was unduly influenced by the spelling in ascertaining the pronunciation of a word. "In almost every part of his principles," says Mr. Ellis, an eminent authority on English pronunciation, speaking of Walker's work, "and in his remarks upon particular words throughout his dictionary, one will see the most evident marks of insufficient knowledge and of that kind of pedantic self-sufficiency which is the true growth of half-enlightened ignorance." Such drastic criticism upon the author of a dictionary which was esteemed the highest authority on English pronunciation during the first half of the last century does not invite confidence in the results of our early orthoepists. Rather it makes us feel that none of them is perhaps entitled to credit.

Probably Doctor Johnson shared this feeling when he exclaimed in the preface to his dictionary, *Quis autem custodiet ipsos custodes?*

So much for the lexicographers of the eighteenth century. Let us now consider some of the pronunciations authorized by them, which have long since been discarded. These will serve as illustrations to bring home to the mind of the reader the truth that our speech is slowly but surely and constantly changing, and that English pronunciation, unlike English spelling, has never been stereotyped in a fast, unvarying form. They will also show how indispensable an auxiliary to our crystallized, conventional spelling has the pronouncing dictionary become.

An interesting illustration is furnished by the word *asparagus.* The popular pronunciation of this word in the eighteenth century was *sparrowgrass.* This was felt by the orthoepists, however, to be a vulgar corruption of the word, and they therefore strove with concerted effort to stem the popular tide and to make the pronunciation conform to abstract propriety as indicated by the spelling. Walker, in commenting upon the pronunciation of the word, remarks, as if apologizing for the theoretically correct form which he recommends, that 'the corruption of the word into *sparrow-grass* is so general that asparagus has an air of stiffness and pedantry.' Another word with a no less interesting history is *cucumber.* This word used to be generally pronounced *cowcumber.* The popular pronunciation of this word as well as of *asparagus,* once so universal, has survived even up to the present in the lingo of the illiterate whites of New England and in the Negro dialect. This vulgar pronunciation which was a thorn in the flesh to the eighteenth century lexicographers, it is instructive to note in passing, was not the result of mere caprice, but was warranted by an old variant spelling of the word. This historic spelling, long since discarded altogether by the users of English, was formerly very prevalent and in good literary usage. Hence little wonder that the vulgar pronunciation for a long time contested the supremacy with the mode of utterance now universally accepted. Even so high an authority as Mr. Pepys refers in his 'Diary' to a certain man as 'dead of eating cowcumbers.' It was not till wellnigh the middle of the last century that the orthoepists Knowles and Smart ventured to denounce *cowcumber* along with *sparrow-grass* as vulgar and therefore tabooed in polite circles.

It is a well-established fact in the history of English pronunciation that in the seventeenth century and far into the following century such words as *spoil, toil, boil,* and so on, were pronounced, even in best usage, precisely as they are uttered to-day in the Negro dialect and by the illiterate whites among us, that is, just as if they were written 'spile,' 'tile' and 'bile.' This is conclusively proved by the

rhymes of Dryden and Pope. It is further evident from the rhymes of the poets of the latter half of the eighteenth century that this archaic pronunciation persisted almost down to the beginning of the last century. This pronunciation was regarded by the orthoepists as antiquated and vulgar, and they did not fail to denounce it in strong terms, warning against its use. In 1773 Kenrick records with mingled regret and disgust that it would appear affected to pronounce such words as *boil, join* and many others otherwise than as 'bile' and 'jine.' But toward the close of the eighteenth century the present pronunciation began to prevail and 'the banished diphthong,' as Nares records with triumphant delight, 'seemed at length to be upon its return.' This same orthoepist informs us, and we may well believe him, that it was the authority of the poets, who had pilloried the offensive pronunciation in their verse, that retarded the progress of the received sound of the diphthong which finally triumphed.

The early lexicographers were divided on the pronunciation of *vase*. Indeed, two centuries have not sufficed to unite their successors in perfect harmony on this question. The word to-day vacillates between four received pronunciations. The great unwashed pronounce *vase* to rhyme with *base* and *case*. Some pronounce the word as if written 'vaz' with 'the broad a.' Others, associating it with its French equivalent, pronounce the word 'vauze.' Others still pronounce it so as to rhyme with *amaze* and *gaze*. Of these four pronunciations the first is the most prevalent to-day, as it also was two centuries ago. According to the Century Dictionary, the word was introduced into English during the latter half of the seventeenth century, and after the analogy of words of its class, it would naturally be pronounced so as to rhyme with *case* and *base*. But the recency of the word and its familiar association with art have given rise to the attempt to make it conform to the analogy of the French pronunciation and sound it as if written 'vauze.' The early occasional spelling of the word as *vause* doubtless contributed somewhat to the extension of this latter pronunciation. This French pronunciation, says the Century, is now affected by many. It is worth while to remark, however, that while the Century recognizes the French pronunciation, it still gives the preference to the old historic pronunciation, viz., that rhyming with *case* and *base*.

Now, in the eighteenth century some of the orthoepists favored one pronunciation and some another. Sheridan, Scott, Kenrick, Perry and Buchanan declared for the pronunciation rhyming with *case* and *base*. On the other hand, Smith, Johnston and Walker expressed themselves in favor of 'vaze.' Walker says that he has uniformly heard it so pronounced, but adds the significant remark that the word is pronounced according to the French fashion 'sometimes by people of re-

finement; but this, being too refined for the general ear, is now but seldom heard.' This French pronunciation, however strange the comment may appear to us in view of his wide acquaintance with English usage, the late Mr. A. J. Ellis averred was the most familiar to him. So the struggle between the several pronunciations of *vase* continues still, and no one can say which will ultimately prevail.

Another interesting illustration of vacillation of usage two centuries ago is furnished in the pronunciation of *either* and *neither*. Like the word *vase*, these words show incidentally how long a time two pronunciations of the same word may linger in good usage before either supplants the other. There is to-day probably as much variation in the pronunciation of *either* and *neither* as there was a century and a half ago. Early in the eighteenth century the *i* sound was conceded by some of the orthoepists as permissible in these words. Two authorities, Buchanan and Johnston, declared for the new pronunciation, that is, 'ither' and 'nither.' But since they were both Scotchmen, their authority was discounted. On the other hand, Sheridan and Walker recommended the *e* sound and used their influence to bespeak for it general endorsement. They recognized the *i* sound, to be sure, but only on sufferance. From that day to the present the battle has waged more or less fiercely between the advocates of these respective pronunciations of *either* and *neither*. Which will ultimately prevail, it is impossible to determine. It may be said, however, that analogy and history are on the side of the *e* sound. Yet the *i* sound appears to be encroaching at present on the former pronunciation. There is still another pronunciation of these words which we now rarely hear. I refer to the old dialectical pronunciation as 'ather' and 'nather.' This pronunciation was current in Doctor Johnson's time, though it probably did not enjoy the sanction of good usage. On being asked one day whether he regarded 'ither,' or 'ether' as the proper pronunciation of *either*, the old Doctor is said to have blurted out in his characteristic crabbed manner, 'Nather, Sir!' This pronunciation survives now only as an Irishism.

Another class of former pronunciations surviving now as an Irishism, or at best as a provincialism merely, is exemplified by such words as *nature, creature* and *picture*. In Dryden's and Pope's time these words were pronounced 'nater,' 'crater' and 'picter.' These pronunciations are preserved still in the Yankee dialect, as shown in Lowell's inimitable Biglow Papers, and of course they are frequently heard on Irish lips. But they long ago dropped out of the speech of polite society. There is one notable exception found in the word figure. The variant pronunciation of this word as 'figer' survives in standard English as a heritage from the seventeenth century.

Quite as instructive an illustration of survivals in pronunciation is

furnished by the British pronunciation of *clerk* and *Derby*. The English, as is well known, pronounce these words as if written 'clark' and 'Darby.' They used to pronounce *clergy* with the same vowel sound, and many other words besides. But it is a significant sign of the approaching change in British usage in respect to these words that a recent British dictionary, the New Historical, in commenting on *clerk* admits that the American pronunciation of this word has become somewhat frequent of late in London and its neighborhood. (Are we to look upon this as a result of the much-discussed American invasion?) But our British cousins are still wedded to their Derby (Darby) and show no sign of abandoning either the old pronunciation or the custom. Even we Americans cling tenaciously to *serjeant* and show but little inclination to make that conform speedily to the analogy of other words of its class and to pronounce it in accordance with the spelling. But, no doubt, this word, also, in the course of time, will yield to the pressure of analogy, and our time-honored *serjeant*, with the flight of years, is destined to be classed among those pronunciations that have lost caste. The early orthoepists uniformly pronounced this entire class of words as our British cousins pronounce them at the present time, that is, as if they were written 'clark,' 'sarjeant' and so on. Indeed, it is the spelling that has been the main factor in effecting the change in the pronunciation of these words. There is a strong tendency in English to pronounce a word as it is written, and this tendency has been asserting itself with ever increasing force since English spelling has been crystallized and thereby rendered less subject to preference or caprice.

A constantly recurring question, which never ceased to vex the spirit of the early orthoepists, was, where to place the accent in the case of *contemplate, demonstrate, illustrate* and similar words of classical origin. The question at issue here is whether the stress shall fall upon the antepenultimate or the penultimate. Even with all the accumulated knowledge of the centuries we are no nearer a solution of this perplexing question than were the Elizabethans. Shakespeare could say indifferently cónfiscate or confíscate, démonstrate or demónstrate. Here the battle has been waged between the scholars, on the one hand, who insist upon strict propriety, and the uninitiated, on the other, who follow the line of least resistance and by intuition place the accent upon the initial syllable. As is evident at a glance, these words come to us from the classics. The scholars therefore, somewhat pedantically, insist upon retaining the stress on the syllable which bore it in the original Latin or Greek. *Per contra*, the common people, who know 'little Latin and less Greek' and care not a fig for the original accent, instinctively throw the stress upon the first syllable, in keeping with their feeling for their mother tongue. This feeling

for the language, which the Germans call 'Sprachgefühl,' is, after all, a safer guide than the rules laid down by the pedants. Candor compels us to admit that the popular tendency is more in harmony with the genius of our vernacular. But the scholars have made a brave fight for what we may denominate abstract propriety, and the result, thus far, is a drawn battle. Each side has scored some points, and each side has had to make some concessions. Thus *balcony, academy, decorous* and *metamorphosis,* to cite a few concrete examples, have finally triumphed over the earlier pedantic pronunciations, which required the accent on the penult of these words. *Horizon,* on the other hand, stands as a monument of a concession to the learned, since this word in Elizabethan times had the stress on the initial syllable, as had also the name of the month July. Popular usage in favor of the received pronunciation of *auditor, senator, victory, orator* and many similar words has achieved a decided triumph over the early orthoepists, who, it was very obvious, were fighting a losing battle in their efforts to retain the classical accent.

It follows that pronunciation is the resultant product of several forces which are silently but constantly acting upon the living language. There are, to be sure, various methods of pronunciation, but the standard is that sanctioned by the most cultivated circles of society. Now, it is the function of the pronouncing dictionary, and its sole reason for existence, to determine and record the usage of the most cultured classes. But here is where the rub comes. This is the stumbling-block in the way of the lexicographers. It may seem, upon first blush, that the task of the orthoepist is easy enough. But not so in actual practice. Countless and insuperable difficulties soon begin to loom up a little ahead in the path of the intending orthoepist, and he finds, to his regret and his occasional disgust, that the way he has marked out for himself is not strewn with roses. It is an arduous undertaking which holds out but meager hope of successful accomplishment, to make an accurate record of the pronunciation received in any large class of society. The labor and trouble are multiplied many times when an attempt is made to determine the best orthoepical usage in a democracy. There is really no absolute standard of pronunciation in English and there can not be, from the very nature of the case, as Professor Lounsbury has clearly demonstrated in his recent luminous book on this subject.

Yet it is unquestionably true that the pronouncing dictionary is constantly making for uniformity of pronunciation. There is far less difference in English orthoepy at the beginning of the twentieth century, even despite the present diversity of good usage, than there was at the beginning of the eighteenth century. A glance at the history usage. If we may trust Professor Lounsbury, an eminent authority

of English pronunciation will readily convince the reader of this fact. This result is the direct outgrowth of the increased facilities for intercourse between communities, and of the gradual diffusion of education which the last two centuries have witnessed. With the spread of education there go along those habits of speech which are generally recognized to be in accord with best usage and which therefore have most to commend them to popular favor. But till men cease to exercise the right of choice in the mode of utterance, till men prefer, for the sake of uniformity, to say exclusively hóstīle and not hostīle, sérvīle and not servīle, 'rise' and not 'rice,' to mention an example of variant usage, so long will there probably be a diversity of pronunciation and the consequent need for the pronouncing dictionary. This consummation so devoutly to be wished we may expect at the Greek Kalends. We may rest assured, therefore, that the pronouncing dictionary is here to stay.

Every man has his preference as to his pronouncing dictionary, which he regards with more or less confidence and, may be, reverence, as his final authority. To this he resorts in all orthoepical questions, for final solution. This, of course, is a legitimate function of the pronouncing dictionary. The fact is, the vocabulary of the average educated man is so extremely limited and the vocabulary of the language so extremely copious that there are thousands of words of a technical character which even the most accomplished scholars have never once heard uttered. The average educated man who knows that English spelling is a very untrustworthy guide to pronunciation is perforce driven to consult his Webster, or his Worcester, or his Standard, or mayhap his Century. Only then can he pronounce an unfamiliar English word with any assurance of propriety.

Notwithstanding the fact that every educated man has his favorite dictionary, it is probably true that no man's pronunciation is in entire accord with the dictionary he habitually follows. The late Mr. Ellis gave a suggestive test which I believe has never been successfully challenged. "I do not remember," said he, "ever meeting with a person of general education, or even literary habits, who could read off, without hesitation, the whole of such a list of words as: bourgeois, demy, actinism, velleity, batman, beaufin, brevier, rowlock, fusil, flugleman, vase, tassel, buoy, oboe, archimandrite, etc., and give them in each case the same pronunciation as is assigned in any given pronouncing dictionary now in use." Let the reader try these test words and see whether he pronounces this short list according to any received authority in use at the present day.

It may not prove an altogether unprofitable inquiry how our pronouncing dictionaries are made. Such an inquiry, if pursued, may teach us somewhat of the methods of the orthoepists to ascertain good

on English, the method formerly adopted was very much after this fashion: The lexicographer studies in his own library the pronouncing dictionary of everybody who has taken the pains to compile one, whether he be an Englishman, an Irishman, a Scotchman, or an American. He compares these several dictionaries and records their variations. From these he selects those pronunciations which, for any special reason, commend themselves to his individual taste or judgment. These are usually such pronunciations as he is accustomed to hear or himself to use. These are published with the stamp of the lexicographer's authority and approval, and the dictionary is sent out into the world as so-and-so's record of the most approved usage.

This was doubtless the way pronouncing dictionaries used to be compiled. But we may believe that this method is not the course ordinarily followed by the authors of our best modern dictionaries. If our best standard dictionaries to-day were made in this fashion, their authority would richly deserve to be heavily discounted for such carelessness of method. But greater efforts are made by the most recent orthoepists, we may believe, to determine the accepted usage in polite society. Yet, after all, the personal equation enters as an important factor into the compilation of every pronouncing dictionary. The author or authors who compile the dictionary naturally follow their own preferences and prejudices in the matter of pronunciation; and their results, even at best, repose on very restricted and imperfect observation. An orthoepist ought not to be cocksure and dogmatic. Indeed, the proper attitude of the author of a dictionary is that of the late Mr. Ellis. It was quite natural that a man of his superior scholarship and rare orthoepical attainments should have been frequently asked as to the proper pronunciation of a particular word.

"It has not unfrequently happened," observes Mr. Ellis in his monumental work on 'Early English Pronunciation,' in reference to his practice, when appealed to as an authority, "It has not unfrequently happened that the present writer has been appealed to respecting the pronunciation of a word. He generally replies that he is accustomed to pronounce it in such or such a way, and has often to add that he has heard others pronounce it differently, but that he has no means of deciding which pronunciation ought to be adopted, or even of saying which is the more customary."

This attitude will, no doubt, commend itself to the favor of the reflecting and judicious man much more forcibly than that spirit of assumed infallibility which is a sure sign, in an orthoepist, of insufficient knowledge and lack of preparation for his work. The business of a lexicographer is to record what good usage authorizes, not to tell us what we shall not use. The orthoepist who goes farther, and dogmatically asserts that a given pronunciation is correct and another

incorrect, transcends the legitimate bounds of his province. Moreover, he arouses suspicion in the minds of the thoughtful as to his trustworthiness as a guide in matters of pronunciation. For no orthoepist records all the pronunciations sanctioned by good usage, and no one therefore can affirm positively that a given pronunciation of a word may not be warranted by reputable usage in some quarter. Even so high an authority and careful an observer as Ellis lapsed into error in his comment upon the pronunciation of *trait,* claiming that the silent final *t* was an unfailing shibboleth of British practice. As a matter of fact, the pronunciation of the final letter of *trait,* as Professor Lounsbury has clearly shown, had been recognized by English orthoepists as allowable for more than a century. It is manifest that one can not afford to be very positive in English orthoepy: if he is, he will be compelled either to retract or to qualify some of his sweeping statements.

The pronouncing dictionary is, as a general rule, a good guide to standard usage, though it can not be relied upon implicitly. When the orthoepists are all agreed upon a particular pronunciation, one ought to be very chary of using one's customary or pet pronunciation that differs. The chances are that it is not in good repute. But when, on the contrary, the orthoepists themselves differ, one may reasonably infer that no statement of any one of them about the proper pronunciation of a word, however positive it may be, ought to be recognized as a binding authority. For no pronouncing dictionary is an absolutely final authority. Nor can it ever justly claim to be, since the pronouncing dictionary purports to record only such pronunciations as are sanctioned by good usage, and good usage ever varies with the living speech, which, like all living things, is always slowly changing from century to century. The change is sometimes so gradual that hardly the lapse of a century will reveal it. Again, for one reason or another, it is so rapid in development that even a generation suffices to record it.

THE BERMUDA ISLANDS AND THE BERMUDA BIOLOGICAL STATION FOR RESEARCH. II.

By Professor EDWARD L. MARK,
DIRECTOR OF THE ZOOLOGICAL LABORATORY OF HARVARD UNIVERSITY.

BEFORE speaking about the life in the seas I wish to say a few words about the Bermuda Marine Laboratory. Not very long after my conversations with President Eliot, and when I was considering ways and means of providing an opportunity for students to work at Bermuda, I had the good fortune to make the acquaintance of Professor Bristol, and hear from him for the first time a glowing account of his experiences of several years, and his plans and hopes regarding a somewhat similar undertaking. Our aims had so much in common that cooperation seemed desirable to both of us, and we at length agreed to undertake, with the aid of the Bermuda Natural History Society, to equip and manage a provisional laboratory, which might serve till such time as the colonial government should be able to put at the disposal of biologists a permanent station. Chiefly through the enthusiastic interest of Dr. Bristol, in cooperation with the Bermuda Natural History Society, the colonial government had been led to entertain the idea of establishing a public aquarium for the enlightenment and amusement of people resident in the islands as well as the tourists, and in connection with it a marine laboratory for biological investigations. A joint committee of the Legislative Council and the House of Assembly, consisting of Sir S. Brownlow Gray, chief justice, Hon. Eyre Hutson, colonial secretary, and assemblymen J. H. Trimingham, Nathaniel Vesey and A. Gosling, was appointed to consider the advisability of establishing such a station, and in due time reported favorably on the undertaking. The governor, Lieut.-General Geary, at the suggestion of the committee, entered into correspondence with many institutions and individuals in both Europe and America, with a view to ascertaining their opinions as to the desirability of establishing such a station and the possibility of their cooperation. The replies were all favorable, and a certain amount of support was promised. Early in 1903 Professor Bristol and I were invited by the Natural History Society to visit Bermuda for the purpose of looking into the conditions and giving advice with regard to the general plan and certain matters of detail. This we did toward the end of April. Upon our return, and after the money necessary for the undertaking had been secured, we issued to biologists in the name of

the Bermuda Natural History Society and the universities which we represented an invitation to share for six weeks in the privileges of a temporary biological station at the Flatts, Bermuda. The generosity of the Natural History Society and the liberality of our friends allowed us to provide ample means for collecting and all the requisites for laboratory work, except that we had no running water in the laboratory. The building, however, was only a short distance from the sea, so that this deficiency was not very serious.

Through the favorable terms for transportation secured from the Quebec Steamship Co., and for board and lodging at the Hotel 'Frascati,' it was possible to make the cost of staying six weeks at the station, together with transportation from New York and back, only

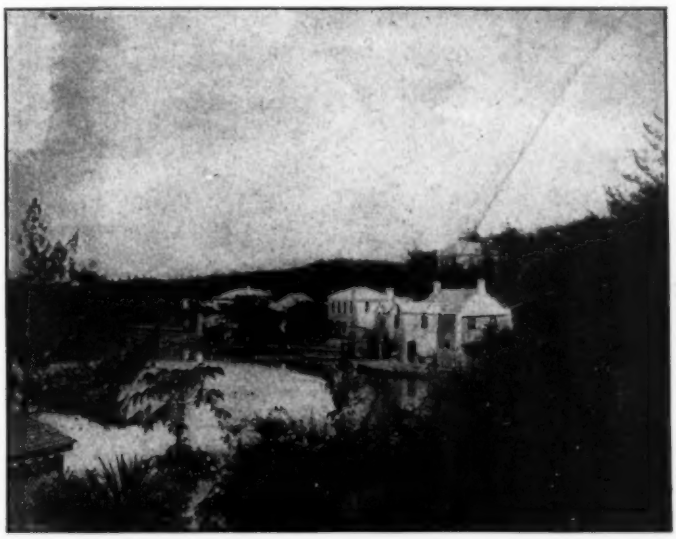


FIG. 13. VIEW OF FLATTS VILLAGE FROM WINDOW OF HOTEL FRASCATI. Photograph by A. M. Miller.

one hundred dollars. Thirty-seven persons availed themselves of this opportunity, and of these thirty-three were engaged in the study of zoology or botany, four being companions of one or another of those who were working in the laboratory. Of these thirty-seven persons about a dozen sailed from New York on June 20, the remainder two weeks later. Arriving in Hamilton, the party was met on board the steamer and welcomed by Archdeacon Tucker, president of the Bermuda Natural History Society; U. S. Consul, W. Maxwell Greene, vice-president; F. Goodwin Gosling, honorary secretary, and other members of the society. A carriage ride of four miles over Mt. Langton and along the north road—from which one gets magnificent views of the great north lagoon and its ever-changing appearance—

brought the party to the Flatts and the hotel. The Flatts village (Fig. 13) centers at the cross-roads near the bridge which spans the narrow passage from the Inlet into Harrington Sound. It contains the hotel, the post office, a half-dozen shops, and one or two scores of dwellings, which range in size and attractiveness from 'Palmetto Grove,' the home of Archdeacon Tucker, to the twenty-foot cottage of the unambitious colored family. On nearing the Flatts the north road runs along the hillside that rises to the south of the Inlet, gradually descending to sea level, at the corners, where it meets the middle road. The cottages are scattered over this hillside, which looks out on Harrington

FIG. 14. VIEW OF HOTEL 'FRASCATI,' LOOKING OUT THROUGH THE INLET. Photograph by Albert Mann.

Sound and affords at many spots beautiful views of that land-locked sea and the wooded heights beyond. The hotel (Fig. 14) is located on a low projection of land that makes out into the Inlet from its south shore and commands on one side a view of the sea (Fig. 15), on the other a view into Harrington Sound. It consists of half a dozen buildings; two of stone (one built as a residence many years ago) placed gable to gable and facing the water; a much newer wooden structure, which, with its broad piazza, projects out over the clear waters of the Inlet; the kitchens and a storehouse behind the older buildings; and, lastly, a new stone building some forty feet square located back of the wooden

one, between it and the public road. This building we rented for a laboratory (Fig. 16); it had been divided up by light partitions into several rooms, and proved to be fairly well adapted to our needs. The laboratories were furnished with substantial work tables, having ebonized tops and banks of drawers. A library of specially selected books and pamphlets from the libraries of the Museum of Comparative Zoology, the Boston Society of Natural History, and the writer, several hundred in number, was arranged in the largest workroom. An ample supply of glassware, reagents and preservatives, dissecting lenses, microtomes, paraffin imbedding appliances and all the other usual equipment of a zoological laboratory were provided, as well as the necessary appliances for collecting, such as dredges, nets, seines, tubs,

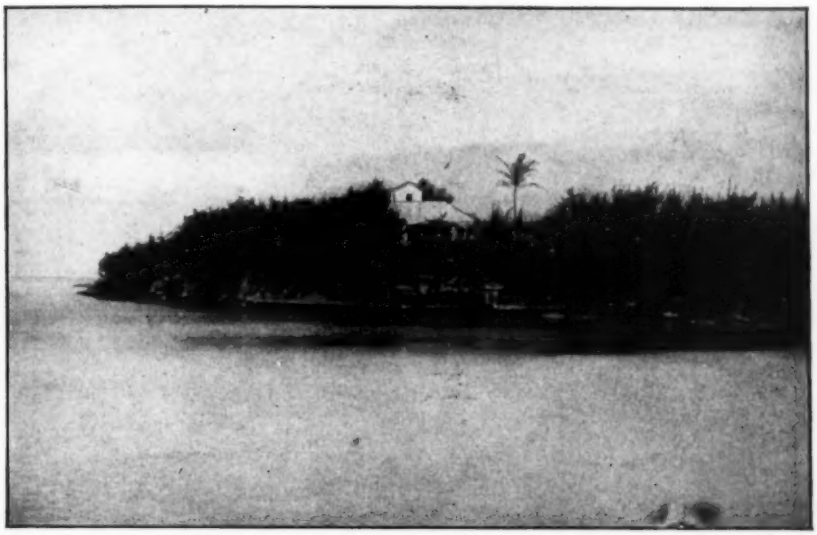


FIG. 15. VIEW OF 'WISTOWE' AND THE INLET FROM THE PIAZZA OF HOTEL 'FRASCATI.'

buckets, sieves, water glasses, et cetera, so that few wants were felt in this direction by any of the party. The number of students was, however, so large that the laboratory building was inadequate for the accommodation of all. When the second party arrived, therefore, a large ground-floor room in one of the stone buildings of the hotel was fitted up with portable tables for those who had less need of appliances for microscopic work.

Very satisfactory means of transportation to collecting grounds, both by land and by water, were provided. For places not readily accessible by boats, wagonettes and carriages were furnished, and those who collected land plants made much use of them. Several persons had brought with them their bicycles and thus were less dependent on

the organized parties. Regular excursions were arranged for nearly every day, except Sundays; frequently two in a day, and sometimes two by sea and one by land. As far as practicable shore collecting and coral 'nipping' on the reefs were planned for the low-tide hours of the day and dredging for other times.

One of the places most frequently visited by land conveyance was Hungry Bay, on the south shore nearly opposite Hamilton. The entrance to the bay is narrow and rocky, yet a great variety of animals are blown in by the southerly winds, and the place has thus become a rich collecting ground. The loose and porous rocks just inside the

FIG. 16. THE LABORATORY, WESTERN FACE. Photograph by C. L. Bristol.

entrance on either shore afford hiding places for great numbers of worms and other invertebrates. Upon turning over these rocks the bottom seems alive with creatures of many kinds. Only half the booty is seen, however, unless the rocks are broken into fragments. Thus are set free boring mollusks, annelids and many other forms that find protection, or a lair, in the holes and tortuous passages of this porous, honeycombed limestone.

In many places the floor of the shallower parts of the bay is covered by a large tubularian hydroid, in others, where the current

is stronger, by great yellowish or greenish patches of colonial actinians (*Palythoa*) belonging to the Zoanthidae (Fig. 17). The upper end of this bay is a swamp of mangroves (compare Fig. 18), on the branches of which numbers of tree crabs (*Goniopsis cruentatus*) clamber about. To catch these creatures requires some skill, two persons usually succeeding better than one, for the crab, when too closely pursued, quickly drops to the ground, even from a height of ten or fifteen feet, and escapes into a burrow, unless a net is dexterously interposed during his descent. Along the edges of the tidal stream near the head of the bay are found in great numbers prawns that are so transparent as to escape observation until they move; they dart about with such swiftness that it is difficult to take them in the net.

When one cautiously approaches the edge of the cliffs that flank the entrance to the bay and looks down on the hard, wave-beaten rocks he sees large numbers of crabs that take alarm at the least motion and scurry away to crevices, or scramble down into fairly deep water, where with their sharp claws they are able to cling to the rough rocks and make almost as good progress as in the air. On the platforms and in the niches of the rock between tide marks are congregated hundreds of chitons (*Chiton marmoreus*), whose shells give proof of the action of the waves, which are almost constantly dashing against them at high water.

In view of the possibility of the establishment of a permanent station, it seemed desirable to keep records of the places where various animals and plants were found. To this end each person was provided with a note book, and to prevent duplication of locality numbers, certain locality numbers were assigned with each book. Whenever a party of individuals made collections together in a circumscribed area, as in dredging, or in shore collecting at particular spots, the same locality number was used by all. To enable future workers to find the precise localities mentioned, these places were designated by latitude and longitude. Fortunately for this plan there had been recently published an Ordinance-Survey map of the Bermudas on a scale of 880 feet to the inch, so that by ruling one of these maps with rectangles ten seconds square it was possible to indicate on the map the position of any locality to within a very few feet.

A card catalogue embracing the names of all the animals and plants arranged systematically will ultimately show, not only what organisms, both living and fossil, are to be met with in the islands and adjacent waters, but also the precise localities at which they have been found, and the conditions under which they live. To this will be added as rapidly as possible the periods of ovulation, etc., so that one may not waste time in searching in the wrong place or at the wrong time of year for the material one needs.

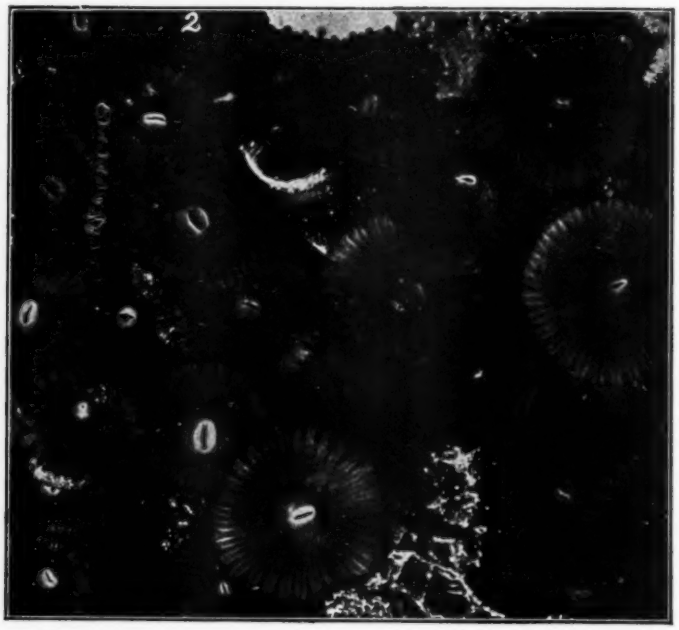


FIG. 17. *Palythoa grandiflora.* A GROUP OF LIVING ANIMALS. Natural Size.

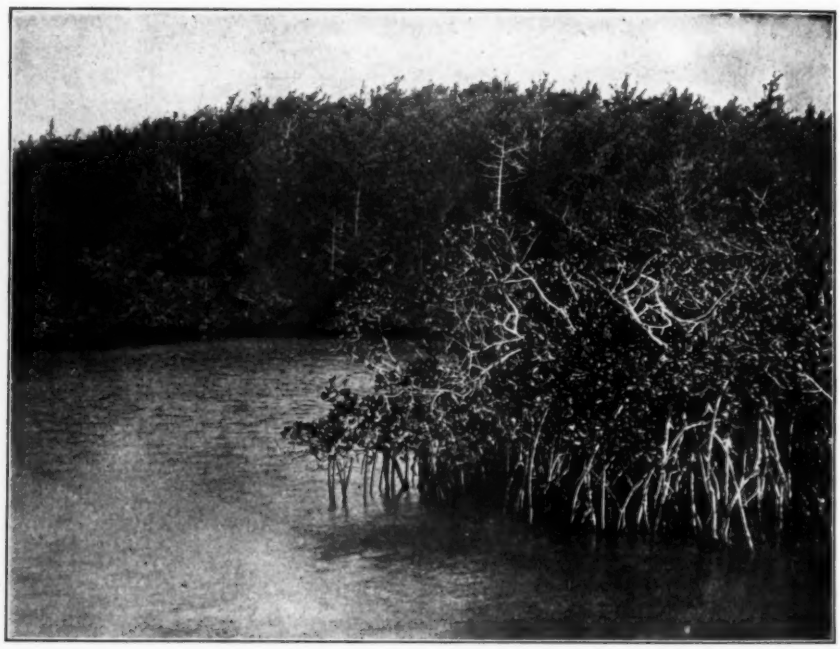


FIG. 18. WALSINGHAM BAY. MANGROVES AND, IN THE BACKGROUND, CEDARS. Photograph by W. C. Van Name.

* Figures 17, 19–23 and 27 are from photographs by A. Hyatt Verrill.

In the immediate vicinity of the laboratory—in the Inlet and in Harrington Sound—are found an abundant supply of many interesting animals. From the stone pier at the hotel are to be seen great numbers of brightly colored fishes: the yellow-banded sergeant majors (*Abudefduf saxatilis*), sea squirrels (*Holocentrus ascensionis*), so called on account of the bigness of their eyes, angel fishes (*Angelichthys ciliaris*), four eyes (*Chætodon bimaculatus*) and many others. The large eye-spots of the four-eyes at the tail end of the body evidently afford protection by misleading their enemies into the belief that they will attempt to escape in a direction opposite that in which they actually swim. Schools of blue fry and other small fishes pursued by their enemies make a flash in the sunlight as they leap from the water and a sound like the patter of rain as they descend. Small shoals of white grunt (*Bathystoma*), that so closely resemble the sandy bottom as to be almost invisible, are slowly patrolling along the beach and often attract one's attention only when their presence causes a commotion among their prospective victims.

The water is so clear that the bottom at a depth of fifteen or twenty feet is seen as distinctly as it would be beneath as many inches of our northern waters. Along the sandy stretches of the inlet, where the current is not too strong, are numerous dark sea-urchins (*Toxopneustes variegatus*), which have the interesting habit of covering themselves with empty shells, seaweeds or any loose available fragments. Just what sort of protection these screens afford is not quite apparent. To the observer looking from above they are scarcely less conspicuous than when unadorned. Their specific form and characteristic color, it is true, are masked, and possibly this is enough to subserve some useful purpose. By digging a few inches deep in the sand at the right spot one brings up another echinoid, the sand-dollar (*Mellita sexforis*). Scattered over the bottom are the apparently motionless but conspicuous sea-cucumbers, which the natives call sea-puddings—the *Stichopus diaboli* and *S. xanthomela* of Heilprin. These often attain the length of a foot or more and leave behind to mark the track of their slow progress a cord or ridge of sand that has been deprived of its nutritive material in passing through their intestinal tract. These are abundant on many sandy bottoms; other holothurians are less widely distributed. In the shallow parts of the Inlet, which are laid bare at low tide, are the burrows of many annelids and other worms. Where the channel is rocky and the water moves with greater velocity the bottom is often gorgeously painted with patches of bright-colored corallines and encrusting sponges. Opposite the hotel an artificial channel cut through the narrow neck of land that separates the Inlet from Harrington Sound is of this nature and affords a rich collecting ground for many invertebrates. With a row

boat and a good water-glass one may study with delight the shores of Harrington Sound and its numerous coves and get beautiful views of the delicate shade-corals (*Agaricia fragilis,* Fig. 19), the many kinds of sea anemones (Figs. 20, 21, 22) and the sponges, which abound there. Collecting is easy and the variety of life great. Occasionally the long "whips' of the Bermuda lobster (*Panulirus argus*) are seen projecting out of some cervice in the rock, as he lies in wait for his prey. If less palatable than our American lobster, the Bermudian has a more graceful form and a much handsomer livery (Fig. 23).

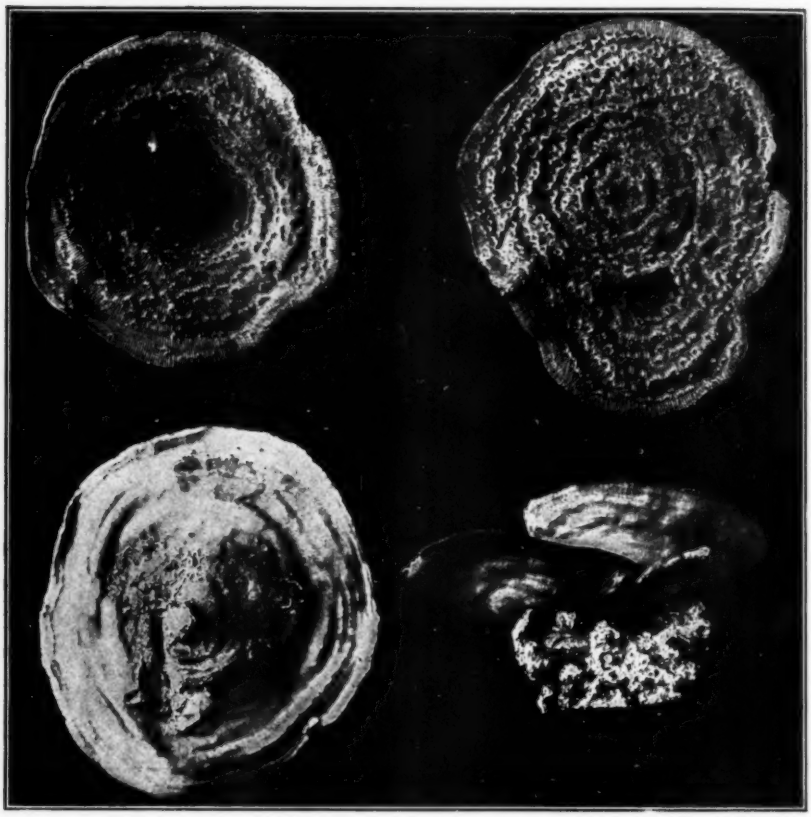


FIG. 19. SKELETONS OF SHADE CORALS.

In addition to a thirty-foot sail boat with its glass-bottomed fish well, such as the native fishermen use, the station was furnished in the summer of 1903 with a steam launch (Fig. 24) some 35 feet long, the *Minnow.* For three fourths of her length she had a light wooden deck and side curtains, which could be lowered to keep out sun, rain or spray. Her pilot house was low, but roomy, and served as a forward cabin as well as wheel house. In this launch almost daily

excursions were made to various parts of the archipelago, according as the conditions of wind and tide favored this or that locality. For all purposes except that of dredging she was well suited to our needs, for, being of light draught, she could be used about the shoals and flats with safety and ease.

I recall with pleasure not only my own fascination, but also the

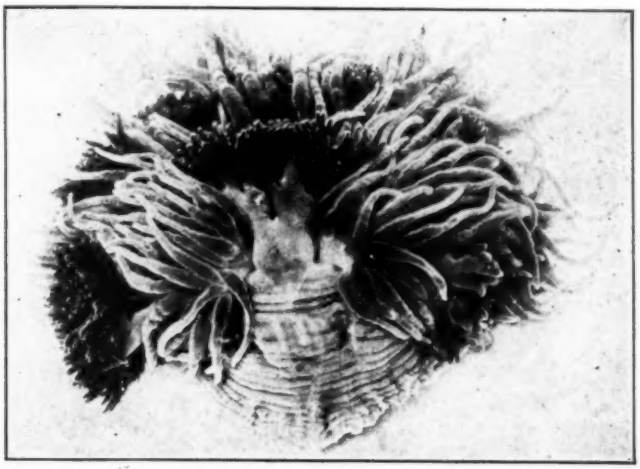


FIG. 20. ACTINIAN (*Lebrunia Danæ*). ×⅓.

expressions of delight which involuntarily came from the lips of all who, with water-glass in hand, peered down into the fairy-like gardens of the sea, as we slowly drifted with the tide or lay at anchor in the midst of one of the great coral patches that flourish over extensive

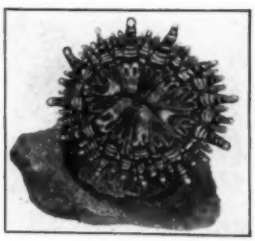


FIG. 21. *Anemonia elegans*, VERRILL. ×1¼.

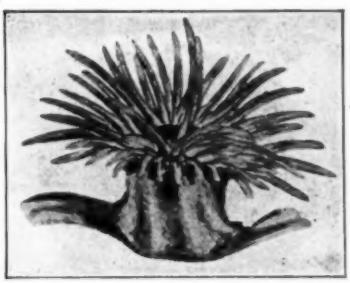


FIG. 22. *Phillia rufa* VERRILL. ×⅓.

areas of the north lagoon. I confess the pleasure was so great that the spirit of the collector was suppressed for the time being; it seemed sacrilege to touch with violent hands a picture that showed such harmony of form and color—the waving plumes, the graceful branches

of the gorgonias; sea fans in purple splendor; coral heads of gold and green; great splotches of colored sponges encrusting the rocks; the soft seaweeds; here and there deep channels with nothing but the clear water and the white sand beneath it; and in and out among this maze of growing things, the graceful, noiseless fishes in such array of colors as is scarcely credible, much less describable. I believe it may be truly said that one who has never seen such a tropical sea-garden

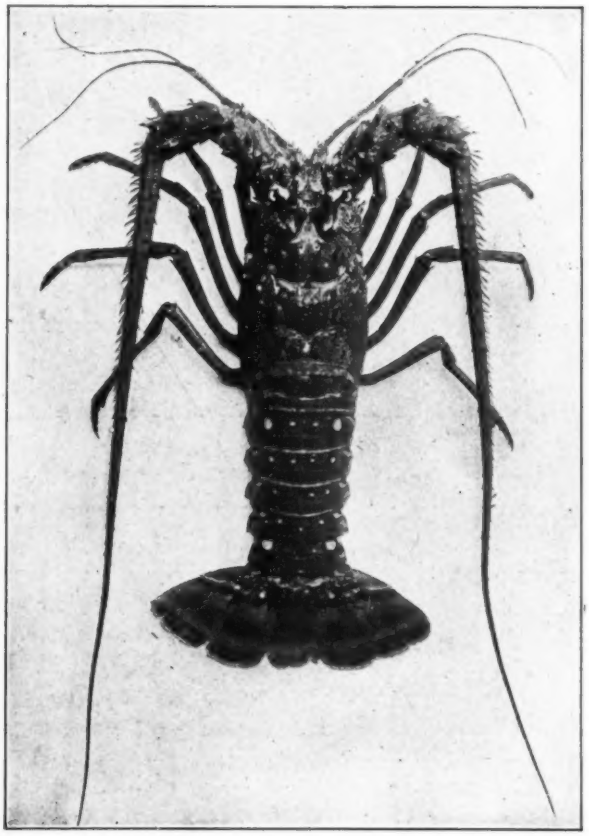


FIG. 23. BERMUDA LOBSTER. About ¼ natural size.

can not have the remotest idea of its charm. There was only one consideration that could reconcile me to the wanton work of collecting these beautiful things and robbing them of all their native charm; that was the fact that, work as diligently as we might, we could not deface one in a thousand of these fascinating spots. I think there is no other single experience I would willingly exchange for this; and yet I recall one other, of a somewhat different nature, that made a

strong impression on me. As three of us were out one afternoon off the south shore beyond the reefs fishing in about sixty fathoms, there came floating past with the tide a school of jelly fishes, the common *Aurelia*. I had before seen *Aurelia* almost cover the surface of the sea, but never before had I been able to look down, as then, and see them in the depths of the sea. They were seemingly without end, a vast procession, smaller and smaller the deeper one gazed, until they seemed mere specks, such was the clearness of the water.

For use in dredging a much larger steamer (Fig. 25), the *Intrepid*, was for a part of the time at our command in place of the *Minnow*. This steamer was provided with a boom in front of the pilot house, which much facilitated dredging operations, and the forward deck was

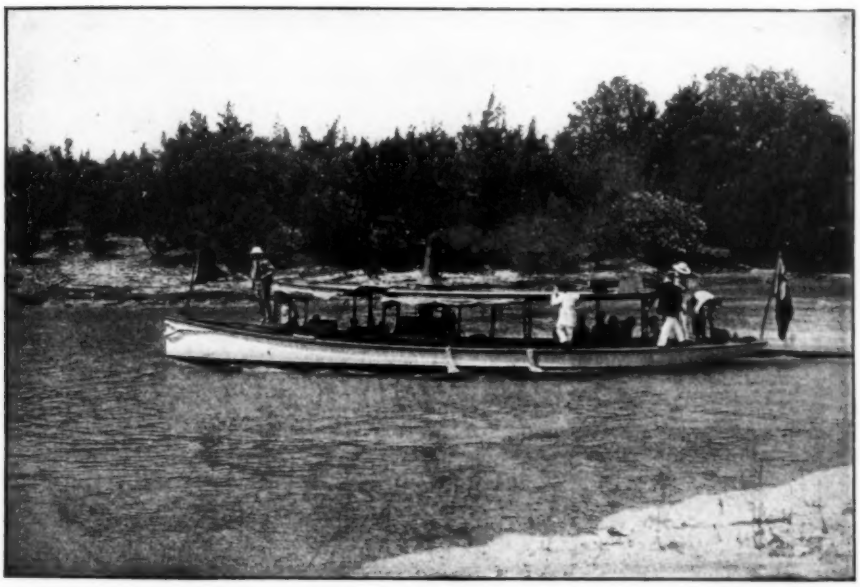


FIG. 24. THE 'MINNOW' STARTING ON AN EXCURSION. Photograph by Albert Mann.

a convenient place for inspecting the dredgings, assorting tows, etc. This was the steamer that had been employed by Mr. Agassiz during his explorations in 1894. With her we made, besides other excursions, several trips to North Rocks (Fig. 26)—three sole survivors of a land mass that doubtless extended in previous times along the northern border of the lagoon, as the present land area now does along its southern rim. It is only on the calmest days and at lowest tide that one may safely land on the plateau from which these three pinnacles, called North Rocks, arise. The steamer can approach within a half or a quarter of a mile and then must anchor, while in rowboats the collectors

make their way to this sea-washed platform. On the sea face the rock, which is an æolian limestone, is slightly raised above the general level of the floor, and is overgrown with nullipores and other corallines,

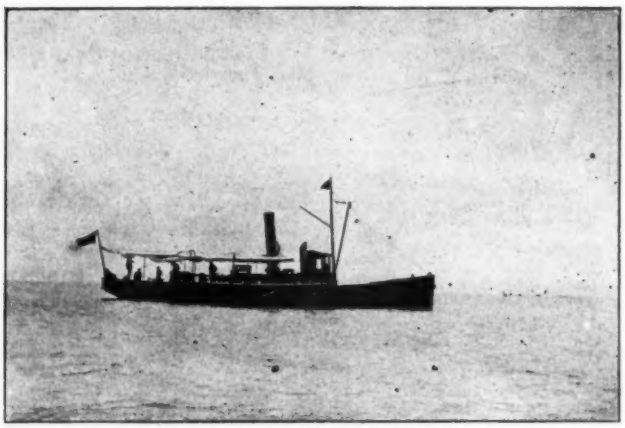


FIG. 25. THE 'INTREPID.' From a photograph by L. J. Cole.

as well as non-calcareous algæ; and here serpulas, millepores and porites abound. Even at low tide this rocky platform is barely above water, and it is so honeycombed and porous that its surface is very

FIG. 26. NORTH ROCKS. From a photograph by Phelps Gage.

irregular. The flatter portions are covered here and there with patches of the curious Zoanthidæ. There are innumerable pools and channels all showing the greatest variety of color in the plant and animal life that clothes their sides and bottoms. Here in the pools and passages,

is a greater wealth and variety of life than can be found in an equal area elsewhere in all the Bermuda archipelago. Located on the very edge of the outer reef, where breakers are always running, save in perfectly calm weather, the conditions seem to be especially favorable for many of the marine organisms. Numerous small and brilliantly colored fishes dart about in the pools, and escape into the crevices of the rock as one attempts to scoop them up. The great black sea-urchin (*Diadema setosum*) bristling with slender spines is firmly ensconced in niches in the rocky floor and usually defies all attempts at removal. But by breaking away the rim of protecting rock this urchin may sometimes be dislodged. Unless great care is used, however, his spines, which are like needles, will penetrate the flesh, where they are sure to break off and become a source of great irritation if not promptly removed; but they are so brittle that removal is not an easy matter. Crabs both great and small are everywhere, and the little hermits with their molluscan shelters of various kinds and sizes make a grotesque appearance as they scuttle away to cover.

One of the most novel sights that I saw in these tropical seas was viewed through a water-glass near North Rocks. A school of small fishes (*Atherina*) swimming in a nearly spherical mass ten or fifteen feet in diameter, seemed to be slowly revolving through the water as its individuals swam round and round in an almost solid mass. It was not at first apparent how the mass preserved such a constant form, but at length it was seen that a few individuals of another and larger species of fish were acting the part of the shepherd dog, and that the smaller fishes were actually being herded—a flock of submarine sheep. Nor do the herding fishes prey upon their flocks. The explanation is interesting. Three kinds of fishes are involved in this association. The herders accompany and 'round up' the smaller fishes, so that other kinds of fish which are wont to prey upon them may, as they approach with murderous intent, fall victims to the herders.

Picturesque Castle Island, which still contains ruins of early fortifications,—some of them possibly dating from the early part of the seventeenth century,—once guarded the entrance from the sea through the channel of Castle Roads. From the floor of this channel the dredge brings up many interesting animals: the great conchs (*Strombus gigas*), the shells of which are still prized by tourists, living Foraminifera of several kinds, and, best of all, the Caribbean *Amphioxus*. This species was dredged in considerable numbers at various places during the summer of 1903, and especial attention was given during the past summer to finding out how widely it is distributed, and the conditions under which it thrives. As a result

we now know that there are ten or a dozen localities where it is found in large numbers, and that a fairly coarse clean sand and strong currents of clear water are conditions that it generally seeks. The peculiar odor, resembling that of iodine, which is a noticeable feature of the '*Amphioxus* sand' in the Bay of Naples, was not recognized at any of the collecting places examined by us. Incidentally in our dredgings for *Amphioxus,* it was noticed that there are many sandy bottoms and beaches which are inhabited by large numbers of a rather small *Balanoglossus.* The western portion of Castle Harbor contains brain corals (*Meandra*) in great abundance, many of them attaining an enormous size and weight. The rocky shores, overgrown with encrusting sea-weeds, are a favorite browsing place for the great opisthobranch mollusks (*Aplysia*), which the Bermudians call sea-cats (Fig. 27).

FIG. 27. THE SEA CAT. (*Tethys* [*Aplysia*] *dactylomela*). × ⅓.

Off the south shore, at a distance varying from a few rods to a quarter of a mile, runs a rocky ledge,—a kind of barrier reef,—over which the sea is breaking incessantly. Here and there the rocks take on the form of a huge bowl or crater (Fig. 28), from the rim of which the water pours over after each swell of the sea in a beautiful cascade. These diminutive atolls are known locally as 'the boilers.'

During almost every excursion through the northern lagoon there were encountered extensive patches of floating gulf weed (*Sargassum*), which, I may mention, grows at certain points along the south shore. An examination of the larger masses almost always yielded an abundance of various crabs, bryozoans and nudibranchs, some of the latter being most beautifully colored; frequently the less common fishes, such as the pipe fish (*Syngnathus*) and the grotesque *Antennarius,* were found in these floating islands, evidently their natural home. After protracted strong winds there are thrown upon the beach long windrows of gulf weed, which harbor a variety of the animals that live on the open sea. At such times the Portuguese man-of-war (*Physalia*) is frequently so abundant as to make the beach purple with its floats.

Through the generosity of Captain William E. Meyer, of St. George's, a three-days' trip to the Challenger Bank was arranged for all the members of the station who desired to go. Captain Meyer put at our disposal his seagoing steam tug, the *Gladisfen*, and her crew. Many hauls of the dredge were made and rare corals, crustacea and other invertebrates secured. The edge of the bank is an ideal fisherman's ground, abounding in redsnappers (*Neomæius aya*) and amber-fish (*Seriola dumereilii*). As might be expected, sharks, too, are found there in abundance.

FIG. 28. DIMINUTIVE ATOLLS ('BOILERS') IN THE FOREGROUND; REEF IN THE DISTANCE.

Some of the investigations undertaken by us have already been published as 'Contributions' from the station; others are in press or in course of preparation. Mr. Leon J. Cole's paper on the Pycnogonida (*Proc. Bost. Soc. Nat. Hist.*, Vol. 31) contains an illustrated description and critical discussion of three species, one of which is new. Mr. Addison Gulick has described (*Proc. Acad. Nat. Sci. Phila.*, Vol. 56) some twenty-five species of fossil shells—seven of which are new—from a number of localities, and has pointed out their relationships to shells of Eastern North America and the West

Indies. Notes on birds seen during July and August have been published by Mr. Harold Bowditch (*Amer. Nat.*, Vol. 38). Professor Coe, of Yale University, has published an important paper on one of the very interesting land nemerteans: 'The Anatomy and Development of the Terrestrial Nemertean (*Geonemertes agricola*) of Bermuda' (*Proc. Bost. Soc. Nat. Hist.*, Vol. 31).

Among the other subjects for which material was collected, or upon which investigations were carried on, are the following: The internal parasites of fishes, fossil vertebrates, new marine fishes, shoal-water deposits, land mollusks, insects, myriapods, annelids, land planarians, bryozoans, acalephs and hydroids, foraminifera, diatomaceous earth, marine plants, and the conditions of swamp formation.

During the past summer we had the use of the steam launch *Flora,* owned by Mr. Henry H. Barton, of this city. This launch was larger (about 45 feet over all) and in many ways better than the *Minnow*. This year we were fortunate enough to find at several localities a near relative of *Amphioxus*—the interesting *Asymmetron,* which was discovered several years ago at the Bahamas by Professor Andrews, of Johns Hopkins University. This was first recognized at Bermuda by Mr. Louis Mowbray, of St. George's, who was a member of the station party. It is an interesting fact that, so far as our search extended, *Amphioxus* and *Asymmetron* do not inhabit the same sand banks. The Bermuda *Asymmetron* is much smaller than *Amphioxus* and much more expeditious in burrowing into the sand. *Amphioxus* is remarkably quick in its movements, but *Asymmetron* is quicker. The habits of these two primitive vertebrates, as well as the finer anatomy of their nervous systems and the anatomy and physiology of other organs, were studied by members of the party this year, and will form the basis of special papers to be published later.

In conclusion, I wish to state that the Bermuda government has decided to erect a permanent Aquarium and Biological Station at the Flatts, in accordance with the plans that I have already referred to, and has voted a sum of money (about $20,000) for the undertaking, and a smaller annual sum ($2,000) for its maintenance. It is expected that when the buildings are completed arrangements will be made to have the station open for research throughout the year.

SHORTER ARTICLES AND DISCUSSION.

DOES HIGHER EDUCATION UNFIT WOMEN FOR MOTHERHOOD?

In a very interesting article in the March number of the Popular Science Monthly, Dr. Smith discusses a subject which is vital to the well-being of our nation. The evils which he deplores are real and serious, but they are caused, I would submit, not by excess of *education*, as Dr. Smith has it, but by excess of *luxury* and *indolence*. I am inclined to agree with him that too many of our young people have the higher education bestowed on them, but my reason for thinking so is, not that their intellectuality and spirituality are too highly cultivated and that their ideals are consequently too high, but that they are unworthy of the great boon offered them and, not knowing how to use it aright, are injured instead of benefited: they leave college without having become cultured or intellectual.

There can be no greater mistake than to believe that intellectuality promotes extravagance. Are our college professors and men of science the extravagant members of society? Literature, botany, entomology—even music and art—are inexpensive and healthful pursuits as compared with balls, receptions, dinners and the whole round of social functions.

The most serious enemy to American family life is society—in the narrower meaning of the word. Not only among the wealthier classes do its functions absorb enormous amounts of money and time, but among the middle classes also. Let any of our middle class women who dare, sit down with paper and pencil and write on one side the amount of time given to calls, teas, clubs, golf, dinners and the dress necessary for these functions, and in a column opposite the time given to the intellectual and spiritual welfare of her children. Most of them would not like to show, or look at, the balance sheet. Many of them would say, if they were frank, 'Oh, school takes care of my children's intellects and Sunday-school of their religion.' Too true. And here lies one of the great evils of our modern primary education, to which I will just allude in passing, as it is too vast a subject to introduce here. The school is trying to do mothers' work and necessarily failing, but, owing to the time devoted to this failure, the school is prevented from doing the work which it should and could do and used to do. I will just give one example and pass to a more direct consideration of the subject in hand. For twenty years or more our schools have been trying to instill a love of English literature into their pupils. Can any one who knows the results doubt the failure? They are just launching out on what many of us believe will be a similar futile effort in regard to nature study.

A walk in the woods with a mother or father who has an enthusiasm for botany, entomology or mineralogy is worth ten lessons in the class room or even in the woods with a teacher and forty other children. The book or the poem that mother and child read together because they love it and each other, even if they do not know much about the unities or the functions of the various parts, is more likely to stimulate a love of reading than the most exhaustive and exhausting study in the class room.

Now, how are we to produce mothers who will love this work and hug it to themselves as their greatest blessing?

Certainly, *only by education and culture!* If the college does not give these, reform but do not eliminate it.

Let us glance for a moment at the alternative opened to girls if they do not go to college. Our college girls come mainly, I think, largely at least, from our upper middle classes. Suppose our girl of seventeen or eighteen has just finished her school life, what is she to do? Dr. Smith says: 'Marry.' But really, it seems to me, she will have to wait until she is asked—and meanwhile she will have to occupy herself in some way. The fact of her entering college does not prevent any young man from asking her hand and many a girl leaves college to be married. The question to be solved is simply of how the time intervening between school and marriage is to be passed. If Dr. Smith will study carefully the girls who do not go to college, but who devote themselves to social functions, I think I may venture to predict that his choice of his future daughter-in-law would be more likely to fall upon an earnest college girl than upon one of the social denizens, and that the chances of her having extravagant tastes, indolent habits or poor constitution are less than they would be in the case of the less cultured girl. I believe, but am not sure, that statistics have shown that divorces are much less common among college women than among those who have not been to college.

That a girl's education should not be merely intellectual I readily admit. Sewing, cooking and housework are as much a part of their preparation for their life work as is shop work for our young engineers. But here again we find that mothers are too busy or too indulgent to undertake the task of teaching their daughters and so in the early years the school tries—again with questionable success—to do it for them, and in the later years as a rule it is not done at all—neither for the collegian nor non-collegian.

It is perfectly natural that a girl who has grown up without having done any manual work should not like it when the necessity for it arises, but I doubt very much whether it can be shown that the intellectual girl dislikes it more than the non-intellectual, and our college girl, if she has benefited by her course as she should, has learned the possibility of applying her powers to an uncongenial task and has many more powers to apply than her less educated sister. Were I a hungry husband, I should have more hope of a palatable dinner prepared by a college-bred wife ignorant of cookery, than from one equally ignorant who lacked the college training.

A word as regards the best age for a woman to marry. It seems to me that the chances for marital happiness are best where a woman marries at about 22, an age at which she can have easily finished her college course and at which she is certainly better qualified to judge of the qualities of the man who asks her to marry him than she was four years before. Suppose she marries a man but a few years older than herself, there is plenty of time for them to have a family of five or six children, which is as many as even an energetic mother can well attend to. Probably her demands in the choice of a husband will be more exacting, not as regards wealth, but as regards mind and soul. Could a better stimulus be found for the improvement of our young men?

As to the physical health of our college girls, I feel sure it will compare favorably with that of non-collegians. Neither class is as well as it should be, the reason being, in my judgment, not excessive intellectual exertion but undue excitement and anxiety. The college girl who is chairman of the dramatic association, or the non-college girl who is chairman of the entertainment committee in church, alike suffer from a mental strain which is much more likely to prove injurious

than the steady and peaceful study of Greek, mathematics or anything else. If the college girl insists, as she sometimes does, upon filling the time which should be devoted to study with social amusements and activities and then crams for her examinations at a late hour at night and with a feeling of intense anxiety, she is unquestionably subjecting her health to an undue strain. But this is an *abuse* of the higher education not its *legitimate* pursuit. The girl who steadily pursues her studies as the business of her life, allowing herself reasonable time for exercise and recreation, is most unlikely to be found in the sanitarium among the victims of 'nervous prosperity.' The 'prosperity' shows where these come from—from the ranks of the luxurious and indolent. The best method of preventing egotism, selfishness, and consequently introspection, is to give our boys and girls such intense interests outside of themselves that they have neither time nor inclination for morbid self-study.

I can not go into the question of men's higher education, but should like to say in regard to Dr. Smith's statement about millionaires that I am quite ready to agree that the higher education is not likely to produce them. If a man wants to be a millionaire I think he does wisely to leave school early. But one of the things to be hoped from our higher education is that it will produce in our men nobler ambitions than those of mere money-getting, and in our women the desire for husbands whose aspirations are of a widely different kind.

Our whole notion needs to have the beauty of simplicity impressed upon it. As Emerson says: '*Things* are in the saddle and ride mankind.' What is the remedy? Less culture? No, more! So much that we shall see and taste the higher pleasure that comes from the intellectual and spiritual, and which is always more simple, more wholesome and less expensive than the material enjoyment which it replaces.

OLIVIA R. FERNOW.

THE PROGRESS OF SCIENCE.

THE BIRTH RATE AGAIN.

THE POPULAR SCIENCE MONTHLY has printed several articles on the birth rate, and especially on the relation of higher education to the decreasing size of the family, as the subject appears to be of such consequence that it should be brought within the range of scientific treatment. It is, however, unfortunately true that the statistics are fragmentary and ambiguous, and that the opinions and theories are subject to such large personal equations as to make them almost valueless. It appears to be the case that only about one half of the alumnæ of the eastern colleges for women marry, and that they have on the average only about two children. One hundred alumnæ would thus leave in their places only fifty daughters, twenty-five granddaughters and twelve or thirteen great-granddaughters. But it is not at all certain that this disastrous state of affairs is due to the college education. It is probable that the marriage rate is lowered by the postponement of marriage to an older age and the ease of earning a living otherwise; but there are no available data to prove that the college graduate is less likely to marry than her sister who stays at home. She apparently does not have a smaller family than the Harvard graduate, who marries into the same class. It may be surmised reasonably that the higher education of woman is a minor factor in the decrease of the birth rate, but that the low marriage rate and small birth rate of college alumnæ are primarily due to physiological infertility of the New England stock and to economic infertility of the upper middle classes.

While these matters are being discussed here without an adequate foundation of facts, a very thorough statistical study of the decline in the birth rate of New South Wales has been made by the government statistician, Mr. T. A. Coghlan. It has usually been assumed that the birth rate will be high in a new country, where there is room and work for all comers. This was in fact the case in Australasia until about 1880. The birth rate was then about thirty-eight per thousand inhabitants, and the average number of children in each family was about 5.4. In 1901 the birth rate in New South Wales had fallen to 27.6 and the average number of children in each family to 3.6. Between 1871 and 1880 to every thousand marriages there were 5,384 children, between 1891 and 1900 there may be expected to be 3,636 children. Mr. Coghlan calculates that of the 1,748 unborn children, the loss of 301 may be attributed to postponement of marriage, of 236 to barrenness and of 1,211 to decreased fertility.

Dr. Engelmann has argued in this journal and President Thomas of Bryn Mawr claimed in her address before the St. Louis Congress that a delay in the age of marriage does not appreciably affect the birth rate; but Mr. Coghlan shows that this is an important factor. When the average number of children is 3.6, a woman marrying at the age of twenty may expect to have five children, at the age of twenty-eight three children, at the age of thirty-two two children and at the age of thirty-seven one child. An unexpected social condition is revealed by the fact that of the 94,708 first births in New South Wales in 1891–1900,

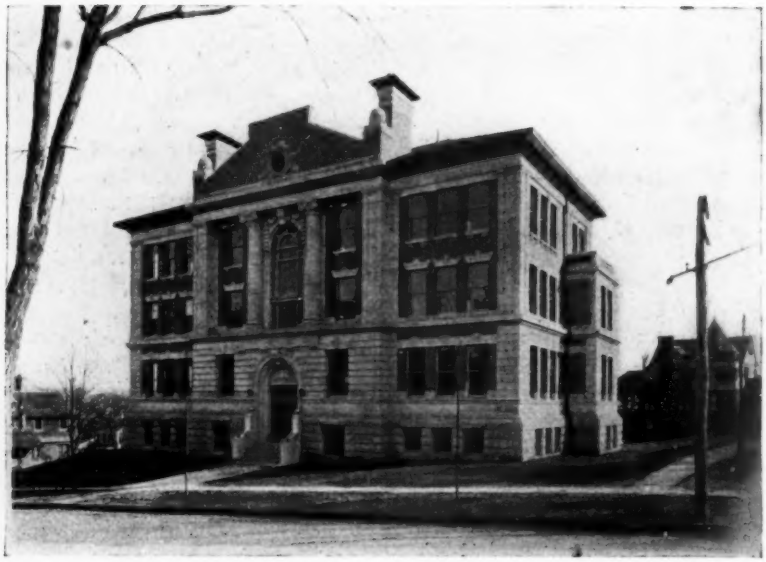
48,271 were of post-nuptial conception, 22,094 of anti-nuptial conception and 24,343 illegitimate. The gradual decline of the birth rate in France and other countries may be attributed plausibly in part at least to physiological infertility, but the sudden change in New South Wales in the course of ten years can not be so explained.

NEW ACADEMIC BUILDINGS.

AMERICAN universities and colleges are more likely to lack men and endowments than buildings. While the salaries of college teachers have remained about stationary and have really become smaller, in view of the increased cost of living and the more complicated social conditions due to larger earnings in other professions, buildings are being continually erected on all sides. And the buildings are certainly welcome. The high school is likely to occupy the most imposing building, except perhaps banks and offices, in each town. The school, college and university express in material form the civic pride of the people somewhat as did formerly the church or cathedral.

We reproduce here illustrations of two of the buildings recently erected for the physical sciences. The Engineering Hall of Washington and Lee University is the gift of Mr. William H. Reid of Chicago. It is of colonial style, in keeping with that of the central university building, of brick with stone trimmings, a hundred feet in length, with an average width of fifty-six feet. The ground floor is used by the department of civil engineering with an electrical laboratory; the sec-

ENGINEERING HALL OF WASHINGTON AND LEE UNIVERSITY.



THE PHYSICAL LABORATORY OF WESLEYAN UNIVERSITY.

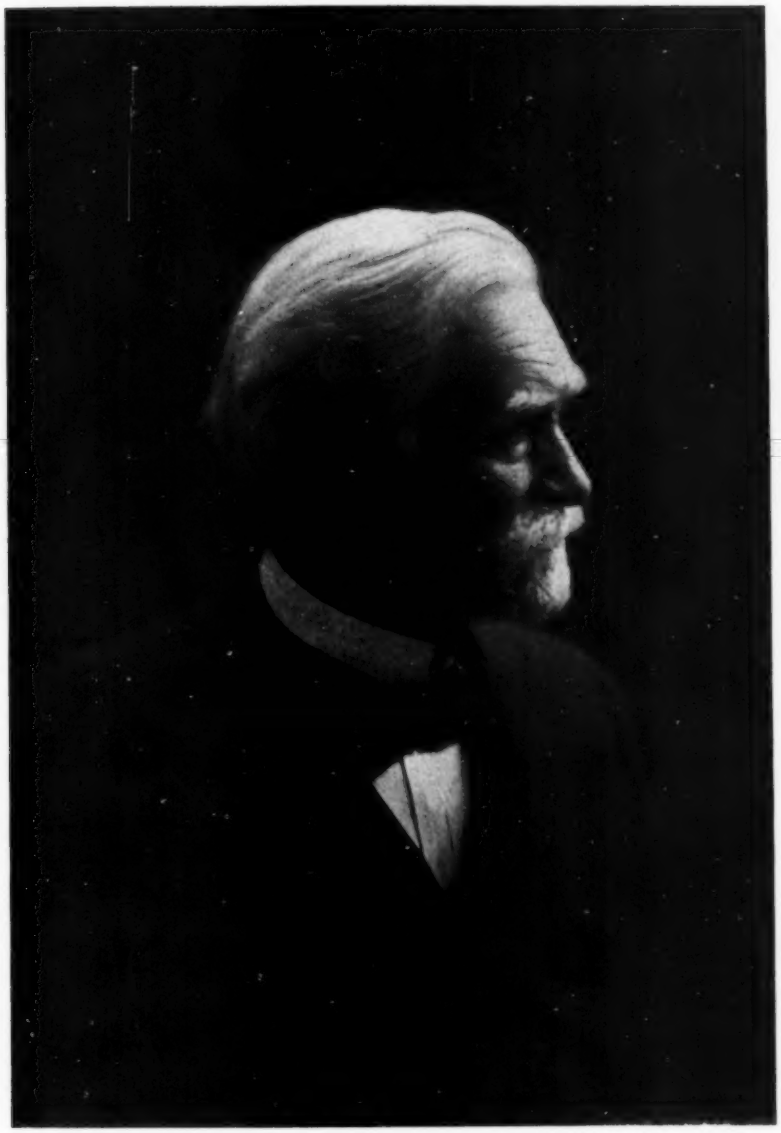
ond floor is exclusively for work in physics; the third floor contains further laboratories for the two departments and drawing rooms. The engineering faculty contains seven professors, with ten other instructors, and provides well-equipped courses in civil engineering, mining engineering and chemistry.

The John Bell Scott Memorial, the physical laboratory of Wesleyan University, was dedicated on December 7, the principal address being made by Dr. Edward B. Rosa, formerly professor of physics at Wesleyan University and now physicist of the National Bureau of Standards. The building is a gift from the late Charles Scott, of Philadelphia, and his son, Charles Scott, who died from disease contracted while serving as chaplain of the U. S. Cruiser *St. Paul*, during the Spanish-American War. The main part of the building is 102x51 feet on the ground plan, and consists of a basement, three stories and an attic. In addition there is an extension of 50x30 feet in the rear which has basement and two stories.

ALBERT BENJAMIN PRESCOTT.

IN the death of Albert Benjamin Prescott, America has lost one of its most honored men of science. Perhaps the chief distinction that can be conferred on an American scientific worker by his colleagues is election to the presidency of the American Association for the Advancement of Science—the number of surviving past presidents is reduced to eighteen by the death of Prescott. Born in 1832, his whole life was associated with the University of Michigan, in the extraordinary development of which his own work was an important factor. He received there the doctorate of medicine in 1864 and was appointed assistant professor of chemistry in 1865. In 1870 he was promoted to a professorship of organic and applied chemistry and was in the same year made director of the School of Pharmacy.

These positions he has since retained as well as the directorship of the Chemical Laboratory, which he assumed in 1884. He served as president of the



ALBERT BENJAMIN PRESCOTT.

American Pharmaceutical Association in 1900, and his contributions to science were largely concerned with the chemistry of drugs, on which he wrote several important books and a large number of special contributions, including several articles in THE POPULAR SCIENCE MONTHLY. He was also the author of excellent text-books on chemistry including 'Qualitative Chemical Analysis,' 1874; 'Outlines of Proximate Organic Analysis,' 1875; 'First Book of Qualitative Chemistry,' 1879, and 'Manual of Organic Analysis,' 1888.

Professor Prescott's death occurred on February 25, when he was in his

MEDAL STRUCK IN HONOR OF CAPTAIN SCOTT, LEADER OF THE BRITISH ANTARCTIC EXPEDITION.

seventy-fourth year. Memorial services were held in the University of Michigan. Addresses were made by President Angell, Dean Vaughan and Dr. W. J. Herdman, of the medical faculty, and Professor M. L. D Ooge, of the literary faculty, and resolutions which had been adopted by the various faculties and classes, were read.

SCIENTIFIC ITEMS.

WE regret to record the death of Alpheus Spring Packard, professor of zoology and geology at Brown University; of George Bond Howes, Huxley's successor in the chair of zoology at the Royal College of Science, London, and of Adolf Bastian, professor of ethnology at Berlin.

THE Royal Geographical Society has struck a special gold medal in honor of Captain Scott, leader of the British Antarctic Expedition, an illustration of which is herewith reproduced.—The British Astronomical Society has conferred its gold medal on Professor Lewis Boss, director of the Dudley Observatory at Albany.—The Prussian Academy of Science has awarded its Helmholtz medal to Professor Ramón y Cajal, professor of neurology at Madrid.

THE University of Pennsylvania has conferred the doctorate of science on Dr. R. S. Woodward, president of the Carnegie Institution; and the Johns Hopkins University has conferred the doctorate of laws on Professor William Osler, who is about to assume the regius professorship of medicine, at Oxford.—M. Moissan, of Paris, and Professor Wilhelm Ostwald, of Leipzig, have been elected corresponding members of the Berlin Academy of Sciences.—M. Janssen, director of the observatory at Meudon, and M. Moissan, professor of chemistry at the Sorbonne, have been elected members of the St. Petersburg Academy of Sciences.—Professor Svante A. Arrhenius, of Stockholm, Professor W. F. P. Pfeffer, of Leipzig, and Professor W. Spring, of the University of Liège, have been elected honorary members of the German Chemical Society.

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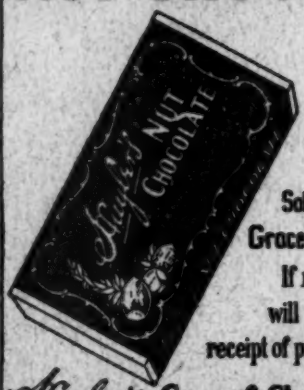

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